#139 MAY

2.95 (3.95 CANADA)

Dr. Dobb's Journal of Software Tools

FOR THE PROFESSIONAL PROGRAMMER

DR. DOBB'S JOURNAL

#138 MAY 1988

Avoiding Software PITFALLS

INSIDE IMAGE FILES

FASTER PATTERN MATCHING

LANGUAGES:

Assembler, C, Pascal

NEW COLUMN

Programming Paradigms

ox is the best

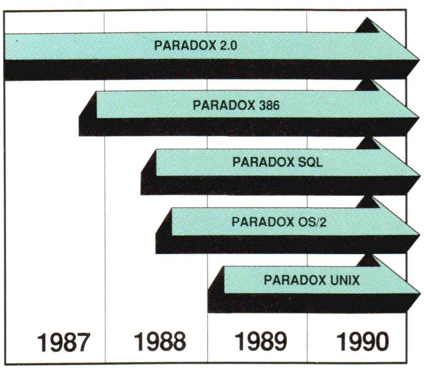
There's no power like Paradox Power

PROGRAM	Overall Power	Overall Performance	Overall Versatility	Single-Record Search (sec.)	Indexed Group Record Search (sec.)	Search without an Index (sec.)	Subtotal 100 Groups (sec.)	Subtotal on Two-File Join (sec.)	Three-File Join (sec.)	Subtotal on Three-File Join (sec.)	Four-File Join (sec.)	Many-to-Many Join (sec.)
Paradox	8.4	9.2	7.5	1.0	6	100	221	325	459	364	322	18
dBASE III PLUS	7.9	8.9	6.9	0.5	17	93	525	1013	646	449	445	39

*Source: Software Digest**

Paradox saves you from future shock

Trends for the future with Paradox



Paradox 386 allows users to take advantage of 16 Megabytes of Memory on a 386 machine. This allows Paradox users to work with databases that could in the past only be handled by minicomputers and mainframes.

Your investment today in Paradox applications is protected as new hardware and operating systems are used in your company. Paradox 2.0 applications will run unchanged on Paradox 386, Paradox OS/2, Paradox Unix and Paradox SQL! All versions of Paradox will be completely application and menu compatible. Paradox SQL will allow access to remote databases via SQL. Users will just type in a query as they normally would, and Paradox will translate that Query to SQL.

“Paradox 2.0 will do for the LAN what the spreadsheet did for the PC

David Schulman,
Bendix Aerospace ”

Paradox makes your network run like clockwork

Paradox is just as valuable to multi and network users as it is to single users. It runs smoothly, intelligently and so transparently that multiusers can access the same data at the same time—without either being aware of each other or getting in each other's way. It works exactly the same way whether you're flying solo or as part of the crew.

“Anyone who hasn't seen the network version of Paradox should take a look. Ansa has dramatically advanced the state of the art in multiuser network databases

Phil Lemmons,
BYTE

Paradox was a delight to use, both as a standalone product and from a local area network server.

Don Crabb,
InfoWorld ”

How to make your network network

To run Paradox 2.0 or the Paradox Network Pack on a network you need:

- Novell with Novell Advanced Netware version 2.0A or higher
- 3Com 3Plus with 3Com 3+ operating system version 1.0, 1.1 or higher
- IBM Token Ring or PC Network with IBM PC Local Area Network Program version 1.12 or higher
- Torus Tapestry version 1.4 or higher
- AT&T Starlan Network with AT&T PC 6300 Network Program version
- Other network configurations that are 100% compatible with DOS 3.1 and one of the listed networks

System Requirements for Single User:

- DOS 2.0 or higher
- IBM® PS/2 and PC, Compaq® PC families and other 100% compatibles
- 512K RAM
- Two disk drives, 3½-inch and 5¼-inch supported
- Compatible monochrome, color, or EGA monitor with adapter

System Requirements for the Network Workstation:

- DOS 3.1 or higher
- 640K RAM
- Any combination of hard, floppy, or no disk drives
- Compatible monochrome, color, or EGA monitor with adapter

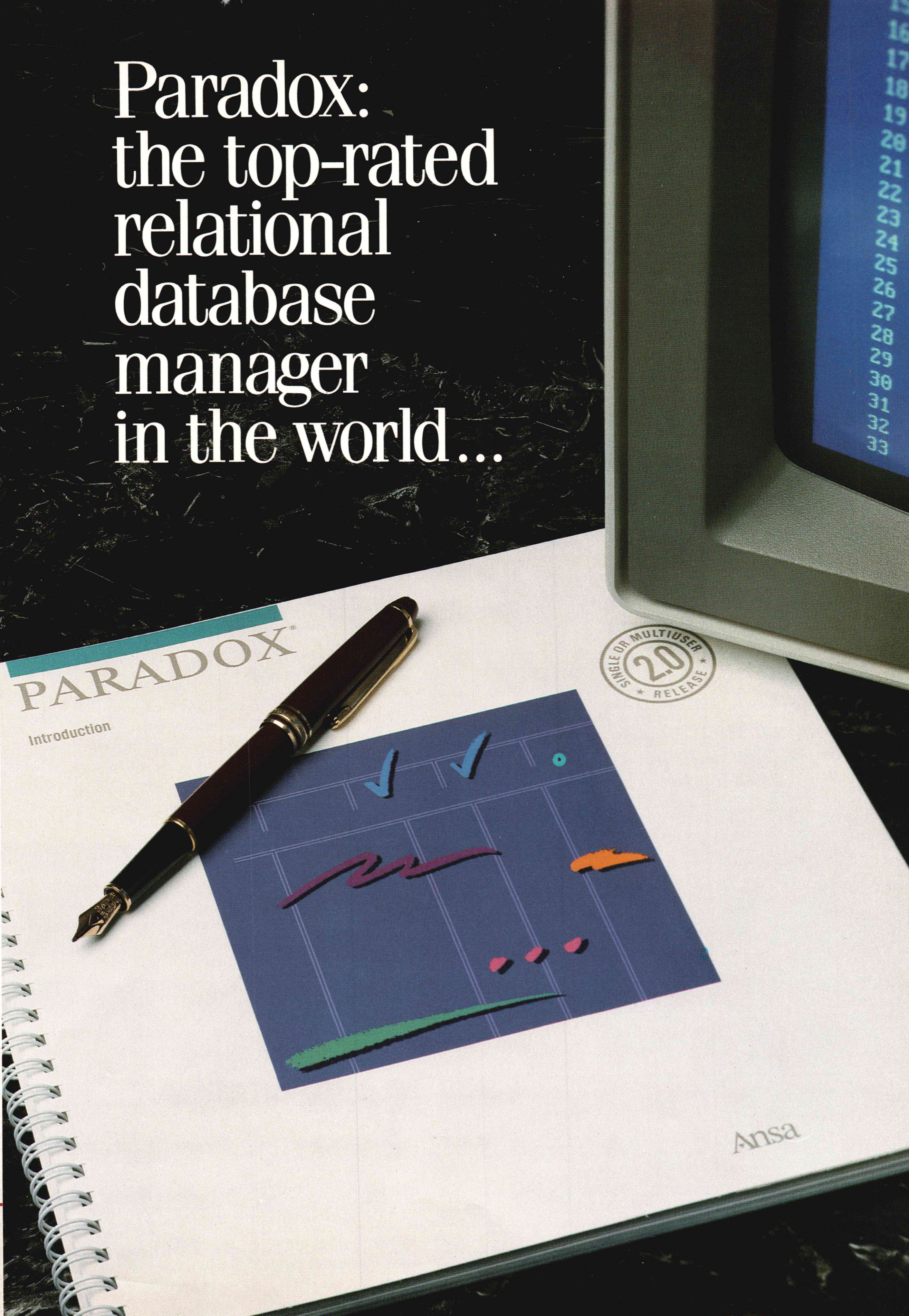
Optional Equipment:

- EMS and EEMS Boards: AST RAMpage Board,™ Intel Above Board® or other expanded memory adapters
- Printers: Compatible dot matrix, letter quality, or laser printer

**Reprinted with permission by Software Digest from its July 1987 report covering 12 relational database programs.*

†Test was designed and executed by NSTL. A 1,000-record and a 10,000-record file were joined. A short text field from the 1,000-record file and a numeric field from the 10,000-record file were selected (using the 1,000-record file indexes). The short text field was grouped and sorted in ascending order, the numeric field was subtotaled for each group, and the results output to a null printer. Test times from the last keystroke on the command sequence until return of program control were recorded and averaged.

DDJ 5-88


Paradox:
the top-rated
relational
database
manager
in the world...
PARADOX®
Introduction
SINGLE OR MULTIUSER
2.0
RELEASE
Ansa

Why Parado

"Paradox® is once again the top-rated program, with the latest version scoring even higher than last year's top score." (Software Digest's July 1987 Ratings Report—an independent comparative ratings report for selecting IBM PC Business software).

All tests for the Ratings Report were done by the prestigious National Software Testing Laboratory, Philadelphia, PA, and the message is crystal clear: there is no better relational database manager than Paradox.

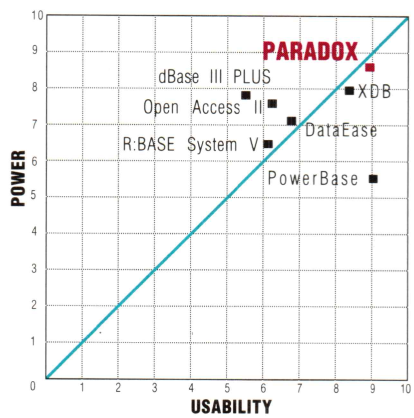
NSTL tested 12 different programs and amongst other results, discovered that Paradox is 3 times faster than dBASE; 6 times faster than R:BASE on a two-file join with subtotals test†.

Paradox does the impossible: combines ease-of-use with power and sophistication

Even if you're a beginner, Paradox is the only relational database manager that you can take out of the box and begin using right away.

Because Paradox employs state-of-the-art artificial intelligence technology, it does almost everything for you—except take itself out of the box.

If you've ever used 1-2-3® or dBASE®, you already know how to use Paradox. It has Lotus-like menus, and Paradox documentation includes "A Quick Guide to Paradox for Lotus users," and "A Quick Guide to Paradox for dBASE users."



*Source: Software Digest**

Ideal programs have high levels of both power and usability. Programs plotted in the upper righthand portion of the diagram above come closest to achieving that ideal.

> ❝ Paradox still offers superior import/export facilities using Lotus 1-2-3, dBASE, ASCII and other file types. It transfers between formats with stunning speed
>
> *Rusel DeMaria, PC Week* ❞

Paradox responds instantly to "Query-by-Example"

The method you use to ask questions is called Query-by-Example. Instead of spending time figuring out *how* to do the query, you simply give Paradox an example of the results you're looking for. Paradox picks up the example and automatically seeks the fastest way of getting the answer. Paradox, unlike other databases, makes it just as easy to query multiple tables simultaneously as it is to query one.

*Source: Software Digest**

Software Digest Rating	Overall Evaluation	Program Name	Version Tested	Ease of Learning	Ease of Use	Error Handling	Performance	Versatility	Memory Requirement	Price
☆☆☆☆	8.7	Paradox	1.1	7.0 - 9.9	7.0 - 9.9	7.0 - 9.9	7.0 - 9.9	7.0 - 9.9	512K	$495
☆☆☆☆	8.2	XDB	1.10	7.0 - 9.9	7.0 - 9.9	7.0 - 9.9	7.0 - 9.9	7.0 - 9.9	320K	$750
☆☆☆	7.6	PowerBase	2.3	7.0 - 9.9	7.0 - 9.9	7.0 - 9.9	5.0 - 6.9	UNDER 5.0	384K	$349
☆☆☆	7.0	Open Access II	2.0	5.0 - 6.9	5.0 - 6.9	7.0 - 9.9	7.0 - 9.9	7.0 - 9.9	256K	$395
☆☆☆	7.0	DataEase	2.5/2	7.0 - 9.9	7.0 - 9.9	UNDER 5.0	7.0 - 9.9	7.0 - 9.9	384K	$600
☆☆	6.6	dBASE III PLUS	1.1	5.0 - 6.9	5.0 - 6.9	7.0 - 9.9	7.0 - 9.9	5.0 - 6.9	384K	$695
☆☆	6.4	R:BASE System V	1.1	5.0 - 6.9	5.0 - 6.9	7.0 - 9.9	UNDER 5.0	7.0 - 9.9	512K	$700

RATINGS KEY
(On a scale of 0 to 10)
Overall Evaluation

☆☆☆☆☆ 9.0 or higher
☆☆☆☆ 8.0 - 8.9
☆☆☆ 7.0 - 7.9
☆☆ 6.0 - 6.9
☆ 5.0 - 5.9

All Other Ratings

■ 7.0 - 9.9
■ 5.0 - 6.9
■ UNDER 5.0

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We've created 4.0 to be highly compatible with version 3.0 and included a conversion program and compatibility units to help you convert all your 3.0 programs to 4.0.

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- Includes a command line version of the compiler

4.0 also

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- Supports 25, 43 and 50 lines per screen
- Generates MAP files for debugging
- Has graph units including CGA, EGA, VGA, MCGA, 3270 PC, AT & T 6300 & Hercules support
- Supports extended data types (including word, long integers)
- Does smart linking
- Comes with a free revised MicroCalc spreadsheet source code

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Sieve (25 iterations)

	Turbo Pascal 4.0	**Turbo Pascal 3.0**
Size of Executable File	2224 bytes	11682 bytes
Execution speed	9.3 seconds	9.7 seconds

Sieve of Eratosthenes, run on an 8MHz IBM AT

Since the source file above is too small to indicate a difference in compilation speed we compiled our GOMOKU program from Turbo Gameworks to give you a true sense of how much faster 4.0 really is!

Compilation of GO.PAS (1006 lines)

	Turbo Pascal 4.0	**Turbo Pascal 3.0**
Compilation speed	2.2 seconds	3.6 seconds
Lines per minute	27,436	16,750

GO.PAS compiled on an 8 MHz IBM AT

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Compiled units (TPU files) are provided so each package is ready to use with Turbo Pascal 4.0. Both POWER TOOLS PLUS and ASYNCH PLUS use units in a clear, consistent and effective way. If you are familiar with units, you will appreciate the organization. If you are just getting started, you will find the approach an illustration of how to construct and use units.

◆**POWER TOOLS PLUS** is a library of over 180 powerful functions and procedures like fast direct video access, general screen handling including multiple monitors, VGA and EGA 50-line and 43-line text mode, and full keyboard support, including the 101/102-key keyboard. Stackable and removable windows with optional borders, titles and cursor memory provide complete windowing capabilities. Horizontal, vertical, grid and Lotus-style menus can be easily incorporated into your programs using the menu management routines. You can create the same kind of moving pull down menus that Turbo Pascal 4.0 uses.

Control DOS memory allocation. Alter the Turbo Pascal heap size when your program executes. Execute any program from within your program and POWER TOOLS PLUS automatically compresses your heap memory if necessary. You can even force the output of the program into a window!

Write general interrupt service routines for either hardware or software interrupts. Blaise Computing's unique intervention code lets you develop memory resident (TSRs) applications that take full advantage of DOS capabilities. With simple procedure calls, "schedule" a Turbo Pascal procedure to execute either when pressing a "hot key" or at a specified time.

◆**ASYNCH PLUS** provides the crucial core of hardware interrupts needed to support asynchronous data communications. This package offers simultaneous buffered input and output to both COM ports, and up to four ports on PS/2 systems. Speeds to 19.2K baud, XON/XOFF protocol, hardware handshaking, XMODEM (with CRC) file transfer and modem control are all supported. ASYNCH PLUS provides text file device drivers so you can use standard "Readln" and "Writeln" calls and still exploit interrupt-driven communication.

The underlying functions of ASYNCH PLUS are carefully crafted in assembler and drive the hardware directly. Link these functions directly to your application or install them as memory resident.

Blaise Computing products include all source code that is efficiently crafted, readable and easy to modify. Accompanying each package is an indexed manual describing each procedure and function in detail with example code fragments. Many complete examples and useful utilities are included on the diskettes. The documentation, examples and source code reflect the attention to detail and commitment to technical support that have distinguished Blaise Computing over the years.

Designed explicitly for Turbo Pascal 4.0, Turbo POWER TOOLS PLUS and Turbo ASYNCH PLUS provide reliable, fast, professional routines— the right combination of pieces to put your Turbo Pascal puzzle together. **Complete price is $129.00 each.**

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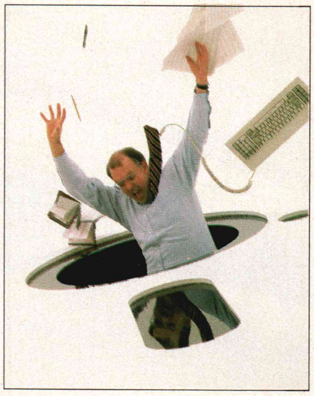
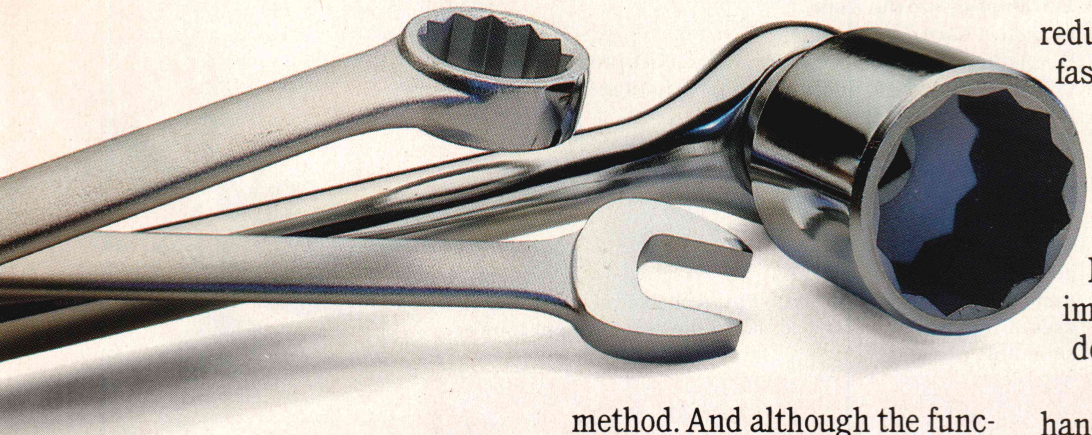


About the Cover
A successful conclusion to any journey means that you have to know where you're going, including which pitfalls to avoid along the way if you're going to arrive safely. These same conditions apply to the goal of developing software that is both well designed and well received. Here's hoping this month's modest contributions help you to avoid those nasty pits of alligators scattered along the way.

Next Issue
In June, C-columnist Allen Holub stalks the wild memory allocator, Mike Swaine reports on a recent gathering of programming prognosticators, and, in general, DDJ examines real-time operating systems, dedicated and otherwise.

Buy Our Tools, And We'



Introducing Emerald Bay. The breakthrough database server technology for developing single and multi-user applications. Emerald Bay provides your programs a common data storage and retrieval method which allows data to be transparently shared across multiple and diverse applications.

And when you buy one of our tools for "C," dBASE™ or Lotus® developers, we'll give you the personal engine—free. No royalties to pay, no licenses to sign.

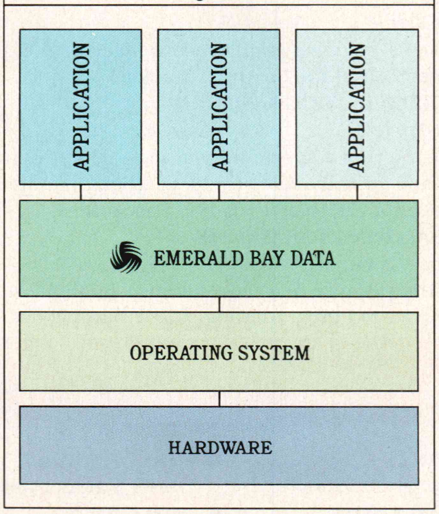
Developed by Wayne Ratliff, the creator of dBASE, Emerald Bay is much more than just another DBMS product, it's an entirely new way to manage data. It's designed to provide an open platform for developing applications in several languages and environments, while Emerald Bay maintains data security, concurrency and integrity.

How The Engine Works

Before, data couldn't be readily shared between applications. But with Emerald Bay, PC applications each share a common data storage and retrieval method. And although the functions of the applications may vary widely, any one application can share another's data transparently; there is no data conversion or translation necessary.

When a PC is an intelligent workstation on a LAN, the Emerald Bay database server technology controls all data security and integrity, including transaction logging with rollback. An application simply makes a request, which is sent to the engine. There, only the essential data is sent back to the workstation. The result is vastly reduced network traffic and faster data access times.

Emerald Bay Architecture



How You Work With The Tools

With the tools we provide, you can easily develop Emerald Bay applications immediately in your familiar development environment.

Emerald Bay technology handles the usually code-intensive management of data, so you can concentrate on what you do best—developing applications.

The ***Developers Toolkit for "C"*** includes well-documented, easy to use "C" libraries that give you the power to create advanced applications, without the effort usually associated with designing and coding a database "backend."

Eagle is Emerald Bay's sophisticated dBASE-like programming language. As the logical evolution of database language, Eagle introduces advanced features, routines and language components, including a compiler, network commands, user-defined functions in "C" and Assembly and automatic index maintenance.

Summit is an "add-in" database management system for Lotus 1-2-3, which gives you sophisticated data manipulation and analysis commands. All three of Emerald Bay's development tools come with the Core Components which include Report Writer, Forms Generator,

I'll Give You The Engine.

an Import/Export facility and the Database Administrator.

The ***Emerald Bay Database Server*** is the heart of the multi-user Emerald Bay technology. Its client/server architecture is superior to current implementations of LAN/DBMS products, and increases total system throughput, while reducing network traffic and access times.

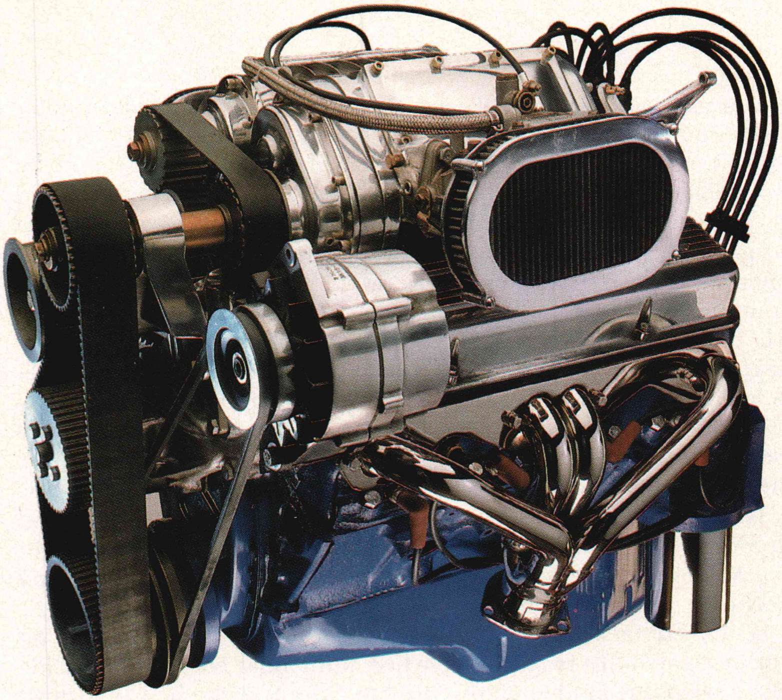
Finally, while providing a path to other operating systems such as OS/2, Macintosh and UNIX, Emerald Bay is a microcomputer-based technology that optimizes your *current* hardware investment.

Free Technical Seminars

We're hosting a series of free Emerald Bay Technical Seminars during April and May in cities across the country. It's your chance to see Wayne Ratliff demonstrate the capabilities of Emerald Bay in person, as well as get some practical experience with the technology yourself.

Call us toll-free at **1-800-777-2027** (and ask for Sandra) for the date and location of the seminar nearest you. Space is limited, so be sure to reserve your seat today.

Emerald Bay. Advanced database server technology. Available *now.*



Emerald Bay Engine Specifications

Data Storage

- Max. databases — No limit
- Max. tables per database — 1000
- Max. fields per table — 800
- Max. field width — 512 characters
- Max. records per table — No limit
- Max. width of records — 10,000 bytes (no limit on ext. fields)
- Max. open databases — 7 (MS-DOS limitation)

Index Storage

- Composite keys supported
- Mixed data type keys allowed
- Keys of up to 100 bytes in length
- Automatic index maintenance
- Ascending and descending keys
- Case independent keys
- Automatic table indexing on record number

Security And Integrity Features

- Access permissions by Read, Write, Delete, Add and Grant
- All five access permissions work on tables and objects
- Read, Write and Grant access permissions operate at field level
- All data other than binary fields can be encrypted
- Transaction logging, with commit and rollback functions
- Full security functions at field and table level
- Optional data encryption at field level

System Requirements

- MS-DOS 3.1 or greater
- Network database server or Single-user computer: PC XT, AT, PS/2 or 386 compatible, 640K, Hard Disk
- Workstation on LAN: PC, XT, AT, PS/2 or 386 compatible, 640K
- NetBIOS compatible networks supported

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CIRCLE NO. 164 ON READER SERVICE CARD

EDITORIAL

Four years ago this month, Mike Swaine wrote his first editorial for *Dr. Dobb's Journal* and in it he talked about *change*—changes at the magazine, changes in the microcomputer industry, changes in general. As it turns out, *change* is the topic of this month's editorial too. You may have in fact already noticed one change. Mike has a new role with the magazine, having moved from the position of editor-in-chief to that of editor-at-large. This gives him a better opportunity to do more original writing, something he's wanted to do for a long time.

For me, Mike's change means a new opportunity. I am Jon Erickson, a former senior editor at *BYTE* and now editor-in-chief of this magazine. *DDJ* has long been one of the microcomputer magazines I've most admired and the chance to lead it into the coming years was a challenge I didn't have to think twice about accepting.

Mike's move doesn't mean that *DDJ* is going to become a radically different magazine from what it has been. I'm as committed to *DDJ*'s original spirit as Mike, and any changes that do take place will be dictated by technological advances and other significant trends that are important to you.

Just coincidentally, the changes at *DDJ*'s parallels some interesting shifts in the microcomputer industry itself. Advances in small system hardware architecture are making life miserable for manufacturers of expensive minicomputers and the emergence (finally) of more sophisticated operating systems like OS/2 promisespowerful new applications. Over the coming months, *DDJ* will be paying particular attention to how those changes affect the software development process.

This changing of the guard, so to speak, provides you with the opportunity to have a say in what directions *DDJ* will go in the future. Take a few minutes to drop me a letter about what you think *DDJ* should be doing and where it should be going. What are we doing right or wrong? What could we be doing better? What aren't we covering that we should be? If you have a specific article in mind that you'd like to write, let me know about it too.

One change I wouldn't mind seeing in the microcomputer industry is a shift away from the tendency of companies to pour resources into litigation instead of R&D. First it was the Lotus look-and-feel suit and more recently Apple's copyright infringement suit against Microsoft and Hewlett-Packard.

There's little any of us can do when influential companies decide to fight it out in the courts instead of on store shelves. But in the meantime, a lot of small (and large) software developers are caught in the middle, wondering whether or not they should sink more resources into further development of Windows applications. In truth, there's probably some merit to the suggestion that part of Apple's strategy is to delay and stifle the development of graphical user interface Windows-based applications. If so, then third-party developers should resent being manipulated like pawns on a corporate chessboard. Maybe by the time this editorial appears, the dispute will be resolved but I don't think so. In the meantime, it looks like it will be the lawyers who profit at the expense of independent developers and end users.

Jonathan Erickson

Jonathan Erickson
editor-in-chief

Dr. Dobb's Journal of Software Tools
FOR THE PROFESSIONAL PROGRAMMER

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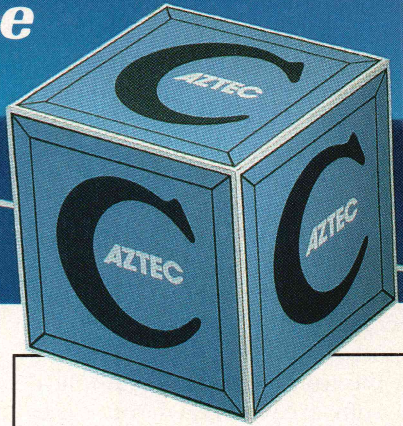

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RUNNING LIGHT

The original theme for this issue was "Designing Applications," and while I still think it's a perfectly reasonable theme I must confess to some surprise at the variety of responses we got from authors. Space limitations forced us to trim the number of articles more than we would have liked, but that's a chronic problem with magazines and is certainly nothing to distinguish this issue. Suffice to say that we are not finished with the topic of designing applications software with this month's articles.

Something that does distinguish this month's issue is Robert Carr's article on guidelines for developers. After reading the article, you might be tempted to dismiss the message—developing for the user, after all, is something that everyone claims to do. Despite the apparent simplicity and familiarity of Carr's advice, I strongly urge you to read the article and then reconsider your development efforts. A careful examination of your current process might reveal a few holes.

It's tempting to dismiss another reminder of the importance of the user in software design. I might even agree (on a good day) that we all learned that lesson years ago, except for the overwhelming evidence to the contrary.

Item: Just a few months ago, a major software house was in the final beta pass for a product with an integrated editor. It was only at this last pass that someone at a beta site complained that the editor was abysmally slow. The reviewer's comments—something about the seasons moving faster than the cursor—caught the developers by surprise: the program had always seemed fast enough on their 386 machines. Alas, the target audience consisted primarily of people using 8088 machines.

Nor are these problems limited to performance issues. A year and a half ago I pretty much trashed Zoomracks in a review that appeared (substantially rewritten) in *BYTE*. The keyboard interface was a Byzantine complex of Alt- and Control-key commands, the mouse interface—what there was of it—was buggy as hell, and the file facilities could be charitably described as primitive. (The PC version, for example, couldn't recognize subdirectories.)

The capper to this second story is that Paul Heckel, the designer of Zoomracks, is also the author of *The Elements of Friendly Software Design* which is a pretty good book on designing applications.

These aren't isolated instances. There isn't a month that goes by that I don't examine a new program that seems hastily thrown together. Little touches like using subdirectories and environmental variables really aren't that hard to add. And besides, we all know better. End of sermon.

This month's news is probably already old to you: Jon Erickson, our new editor-in-chief, is online starting this month. You can meet him back on page 6.

This month's reading list is a short one. Go to the local university library and pull out George A. Miller's classic 1956 paper, "The Magical Number Seven, Plus or Minus Two." Then consider the implications of human bandwidth on your next design. A little thought might make a world of difference for your customers.

Tyler Sperry

Tyler Sperry
editor

ARCHIVES

Parsimony

"A software development project attempts to solve a problem by producing a solution which includes a software system. Any acceptable solution must meet a set of functional requirements and a set of constraints. Constraints are negative requirements (e.g., compatibility, performance, interface specifications). The more requirements a project has, the more difficult it will be to meet them all.

A particular problem has some fixed requirements and many flexible ones (i.e., unspecified or loosely specified). When a system gets designed for execution on a computer, additional constraints must be imposed (e.g., sequential execution, control structures). Additional constraints are imposed when it is implemented (e.g., finite resources, discrete arithmetic). These constraints are 'artificial' in that they did not come with the original problem.

It is important not to impose any more artificial constraints than necessary in order to aid productivity. Then more room is left for trade-offs which can produce a more desirable result. These views come directly from the belief that simplicity is better than complexity. . . ."—*Kim Harris, "The FORTH Philosophy,"* DDJ, *September 1981.*

Syntactic Sculpting

"A hacker is an artist, and computer artistry is not distinguished from other art forms except in the medium chosen. . . .

"It is the nature of great art that it compresses a great deal of design, intellectual sweat and individual personality into the created object. There are no great paintings painted by a committee or artists. Curiously, it seems to matter little what tools the artist had, or where his starting point was, provided that his accomplishment from that point exceeds what the rest of us could have done. Ansel Adams had color and motion available, but he chose to limit himself to black and white stills—and what art he created! A virtuoso on a violin produces art; the same sound from a Moog is ho-hum. . . .

". . .Unlike painting, sculpture, music, and the like, few people can really appreciate the artistry in a computer product. Perhaps that will change."—*Tom Pittman, "Festschrift for Doctor Dobb,"* DDJ, *February 1985.*

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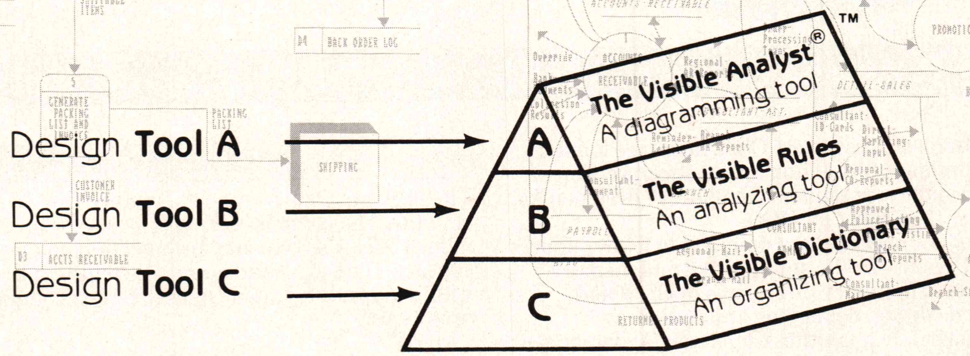

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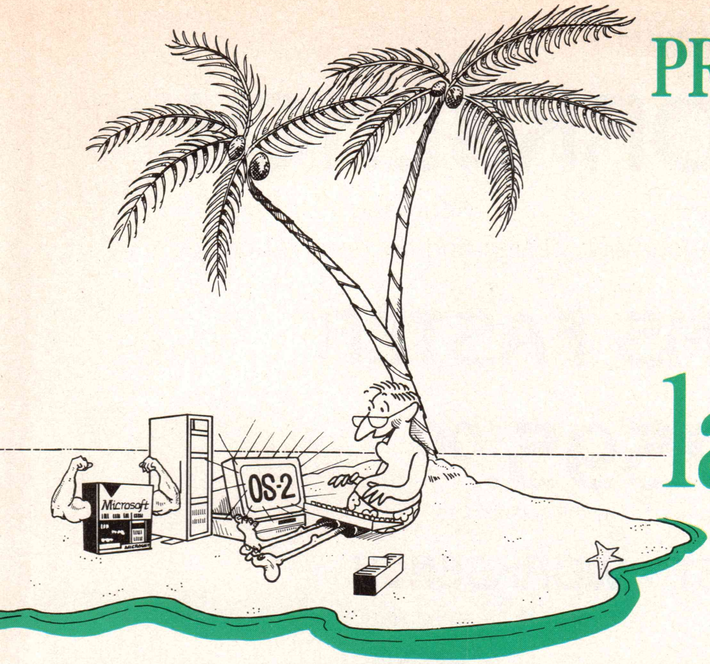

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LETTERS

MASM Complaints

Dear *DDJ*,

It's amazing to see the phrase "screamingly fast" applied to the lumbering leviathan that is MASM 5.0 (Examining Room, February 1988). Compare the reviewer's measurement of 120 instructions per second to the greater than 1,000 instructions per second of Eric Isaacson's A86, which assembles directly to executable code and simultaneously creates a symbol file and embeds error messages in the source code. And it does all this quicker than MASM links. I used it to assemble a 12-module program to a .COM file in 4.8 seconds; it took MASM 54 seconds to assemble the same program and 5.7 seconds to link it.

The real purpose of this letter is to complain that MASM 5.0 no longer supports .COM files and nobody says anything about it. CodeView does not offer symbolic debugging of .COM files and MASM 5.0's symbol file is not compatible with Symdeb or other symbolic disassemblers. So even if you're satisfied with the creepy-crawly rate at which MASM 5.0 assembles and links, you have to give up .COM files or symbolic debugging.

I wish you would have a person review assembly-language products who does not think that assembly language is the "most tedious of programming languages" and that "the emphasis is shifting away from assembler as a primary language" and does not call assembly language "assembler." A person who can't be bothered to distinguish verbally between the language and the translator and who thinks that assembly language is unpleasant will not pay attention to details important to assembly-language programmers.

I ask you: In what other language can you write an assembler that assembles 1,000 instructions a second while it does other things and ends up occupying 20K? Or in what other language can you write a utility that searches for a file name in a full 10-Mbyte, 70-subdirectory hard disk in 12 seconds? Why do advocates of one tool (a higher-level language in this case) disparage others?

George Frank
Encinitas, Calif.

Kent Porter responds:
In comparison with earlier releases, MASM 5.0 is "screamingly" faster. There are even faster assemblers, and I'll take George's word that A86 is one of them. It's true that MASM 5.0 doesn't produce .COM files directly; you have to run the end product through EXE2BIN if you want a .COM. It's also true that I didn't mention that, and I apologize on behalf of all us reviewers who haven't said anything about it.

Assembly language is indeed tedious. That doesn't mean it's bad, nor did I suggest that it is. It's a tool and it has its place. Most developers have switched to C, Pascal, or Modula-2 because they're more productive (that is, less tedious) languages, writing only high-overhead routines in assembly language. Thanks, George, for setting us straight on the proper use of terminology. When I started programming IBM mainframes in the early 60s, we called the language "assembler," and I think I overheard some other professional programmers still misusing that same term just last week.

It's a revelation to learn that writing about structured programming makes me an "advocate" in some grandiose struggle for language supremacy. Let's try to keep things in perspective, shall we?

Don't Believe Everything You Read

Dear *DDJ*,

I am embarrassed to say that I must retract two statements I made in my letter published in the November 1987 issue of *DDJ* on the subject of teletypewriter terminals. I was careful to get my facts concerning teletypewriters correct, but I was not as careful with the examples I gave of other standards that had outlived the reasons for the standards being set the way they were. I received a letter from Mr. Clive J. Grant, a professional engineer, debunking both of these examples.

I have forgotten where I read the story of the Roman emperor and the railroad gauge, but it was interesting and plausible and I fell for it. According to this tale, the Roman military had a problem with ruts. Ruts in unpaved roads tend to enforce at least a local standard on wheel spacings because a vehicle with a wheel spacing not matching the rut spacing is in difficulty. The trouble was that in different parts of the Roman Empire, there were different local standards, and this created problems with chariots and other military vehicles when the legions were moved from one place to another in the empire. Therefore, the emperor issued a decree standardizing wheel spacings in the empire, and this standard, enforced by the ruts, endured long after the empire had fallen.

When the railroads were first started, so the story went, the developers turned to the carriage makers for the rolling stock, and this resulted in the standard being transferred to rail spacing. In fact, when Stephenson established the railroad gauge, rail systems were in use in the Cornwall mines and he took an average of the mine rail spacings, which varied widely. There is some evidence that there was a Roman standard for wheel spacing, but it may have applied only to Rome and the immediate vicinity and in any event had no connection with the railroads.

The typewriter keyboard tale came from an article advocating the new keyboard layout that is supposed to be much faster. Mr. Grant points out, however, that Sholes, who originated the QWERTY key-

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(continued from page 12)

board, never revealed why he arranged the keys in that manner, so any reason advanced for it is speculation. Further examination of this particular speculation shows that its motivation was not to slow the typist, but rather to reduce key pileups.

On the old mechanical typewriters, if a new key was struck before the previous keystroke had retracted, then a pileup occurred. Therefore maximum typing speed was limited by the time required for the spring to retract the previous keystroke after the key had been released. However, many pileups occurred when a new key was struck with a different finger before the previous key had been released. The speculation was that the keyboard was arranged to assign groups of keys apt to be struck in succession to the same finger and thus ensure that one key would be released before the next was struck. This is not quite the same as trying to slow typing.

I hope that my blind acceptance of interesting stories I have read has not caused too much of a problem by misleading your readers.

David S. Tilton
Manchester, N. H.

HyperCard Ends an Era?

Dear *DDJ*,

I appreciated Mike Swaine's comments concerning HyperCard in "Running Light" in the January issue of *DDJ*. Many of his points were right on the mark. Others, however, were wild shots that may sound logical but not to an ol' Mac end-user. HyperCard will indeed bring about a proliferation of stackware, and no doubt there is going to be a lot of sloppy programming. This, I agree, is inevitable. Will it threaten the Mac user interface as you suggest? This I seriously doubt.

HyperCard is merely the growing momentum in computerdom to making the world of computers more "user friendly." Stackware may indeed become polluted for awhile, as everyone with a new Mac jumps into the programming ring. But when all the smoke finally clears, what you will have is the availability of narrowly focused programs that serve a limited consumer base that would not otherwise be met by commercial programmers. The reason? Lack of interest, lack of monetary reward, and most of all lack of knowledge in or about these highly specialized areas.

The authors of many of these stacks will be professional people like myself who have an interest in a particular area and are acutely aware of special needs. Our reward for meeting those needs will transcend monetary gains. We are by nature not "sloppy," particularly in our work or whatever interests us. It doesn't mean we will challenge Microsoft or even rival Danny Goodman's work, but it will be good. Above all it will meet the needs of small groups of people who would otherwise be ignored.

I don't believe HyperCard spells the end of anything. Just as the Macintosh has made computers easier "for the rest of us," so will programs such as HyperCard make producing programs easier. That is as it should be. The progress that has been made in making computers easier to use in both the hardware and software will not only continue but will also accelerate.

Programming will not be immune from this progress. We will see "home videos" in software, but Microsoft or even your local computer store won't be selling them—any more than NBC or your local T.V. channel shows home videos. There will be a lot of amateurish stuff around, but it won't hurt anything. Indeed, it will help. It will stimulate imagination and generate interest. There will be a lot of really good stuff that you will never hear of because of limited interest and distribution. No, HyperCard isn't the beginning of the end, or even the real beginning—that occurred with BASIC or perhaps even before. It is just one more milestone in the evolution of the information era.

Ronald L. Cox
Poplar Bluff, Mont.

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(continued on page 132)

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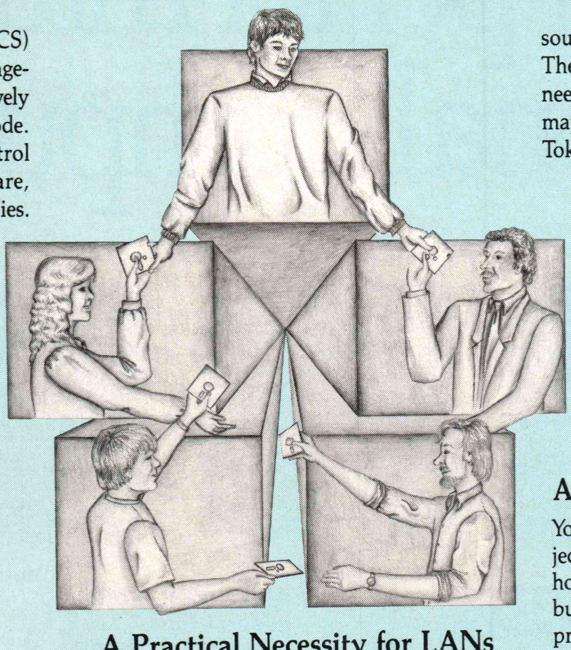

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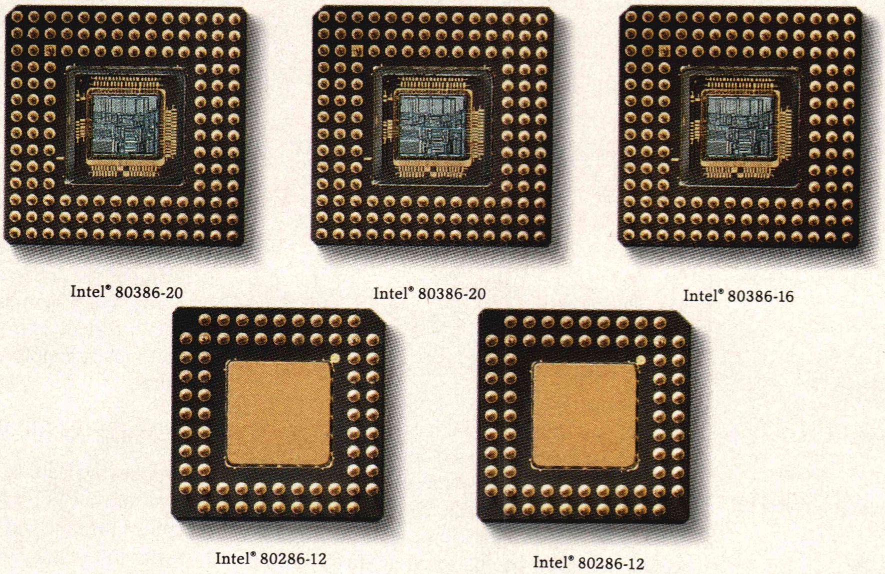

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Developing for the User

by Robert Carr

How do bad software products come about? The reasons vary, but one of the most common faults is when programmers design the product "for themselves," forgetting the product's real users. The key to avoiding this common pitfall is to realize that programming is ultimately for the user—the consumer of the software. You must view the process of developing software as a user-driven, software development cycle.

Software development is much more than programming and debugging; it's an overall life cycle of delivering software products to users. So central is the relationship between the user and the software product that the overall process should be called software delivery, not software development, emphasizing the delivery aspect as the clear goal.

The cycle of software delivery can be broken up into several phases, each with its own axioms. This article lays out eight such phases and their dictums. From the viewpoint of user-driven development, each phase offers a special contribution to the goal of successfully delivering software that makes your users rave about, demand more of, and pay for your software (and ultimately your salary). Although the eight phases are listed here in their natural order, in reality they often overlap; ideally, there is quite a bit of iteration and looping.

A last prefatory comment—although I refer to project teams, all these comments apply equally to the solo implementation effort.

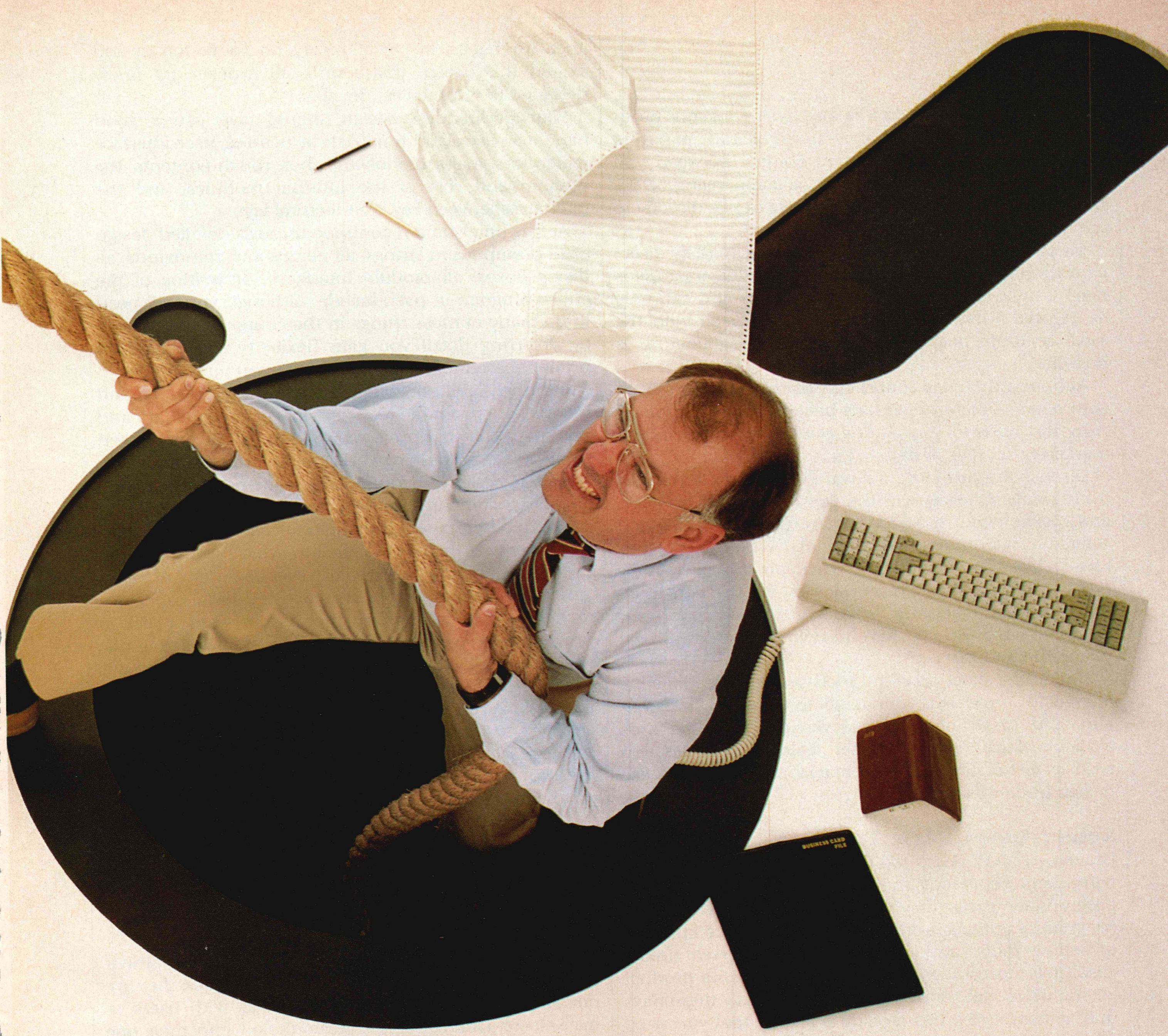
Know Your Users

Just as journalists and writers for decades have offered the sage advice to "know your audience," so should developers know the users of their products.

How can you find your users, so as to know them? Some developers are hired directly (say, as contract programmers or through corporate MIS departments) by their users or users' organizations that will use their products; these developers are fortunate—they know exactly where to find their users. Other developers in some sense develop for "markets" of unknown users; they must find a representative sample of potential users.

Once you've found your users, do something simple with them: talk to them yourself. Talk to

Robert Carr is vice president of software for GO Corp., 139 Townsend St., San Francisco, CA 94107. He is the creator of Framework II and former chief scientist at Ashton-Tate.



Avoiding the common pitfalls of software development is easier with the user's help.

(continued from page 18)

them extensively, and do it before designing your product. If you have the sometimes mixed blessing of having a formal marketing department coming between you and your market/users, insist on accompanying or bypassing the product-marketing people to talk directly to users.

Much useful information can only be gained by direct contact with users. Software that makes users happy is hard to deliver on time and within costs and can only be created when design decisions are made with the most accurate projection of the users' reactions as is possible.

Although this may sound surprisingly simple, talking with users yields tremendous benefits when compared with the costs of presenting your users with formal marketing surveys or detailed product mock-ups.

Discuss the proposed software with them. Have they used similar packages in the past? What did they like and dislike about them? What are their hardware and software environment requirements? When would they ideally like the software by; when do they absolutely need it by? Or, if you're developing for the consumer market, what marketing windows do you have?—for example, when do you have to deliver in order to beat competitors to market?

One of the most powerful tools you have for meeting a targeted ship date is your ability to adjust the functionality and scope of your first version to fit the time available. Early, extensive user dialogue provides you with a gestalt feel for your market so you can make design trade-offs intelligently.

Select Appropriate Tools

Craftsmen need sharp tools. Happily, because personal computers represent the first mass market ever for programmer tools, they're beginning to host the best programming tools ever. Unless you are in the business of selling tools, avoid building them yourself unless absolutely necessary—your job is building the product for the users, not tools for yourself. It's likely these days that someone else has already built the tool you need and is willing to sell you a copy for a few hundred dollars. Buy it and profit.

As with tools, so with building blocks. Seek to partition your architecture such that as many pieces as possible can be subject to the "buy vs. build" decision. Strive to prejudice yourself toward buying. And even when the final version shouldn't be shipped with a preexisting building block, consider using it in the early phases of your project so as to get the overall system running as early as possible. This is a vital technique, supporting the evolutionary-development technique discussed later.

Spend Time on Preliminary Design

Now that you understand the needs of your users, don't rush into programming; instead, spend adequate time designing an architecture that meets all major product requirements, including user interface and performance. Go this far, but by all means do not go too far and extend this design phase until all aspects are finely designed to the smallest details!

Your preliminary design should give you a good handle on key algorithms, data structures, user-interface metaphors, major menus and their rough contents, the number and role of the internal modules, and the interfaces between key architectural layers.

At this point do not continue through detailed design of all prompts and strings, all menus and commands, all dialog boxes, all module interfaces, or writing of the entire program in pseudocode. Although you will need to do many of these things in the course of the project, by deferring detail you gain flexibility to change the product based on what you learn as you build it.

Although much of software engineering research and theory stems from the requirements of large military and aerospace software projects, we in the PC business need to be wary of applying these techniques to our work. What's necessary to produce satellite-control software at a large company is not necessarily the appropriate software development paradigm for us. And nowhere is this more true than in the need to avoid committing the complete design to paper before ever beginning to build.

Now is the time to perform selected tests, especially to highlight major performance issues—run a test to prove your design is sufficiently efficient. If, for example, you wonder if your windowing environment can paint characters fast enough, then write a test program now. If it doesn't, you know you have to redesign your display algorithms to minimize character painting.

The reason behind spending adequate time on design is to put your best efforts into avoiding major surprises or gotchas in the overall design of the product; these are the most costly to rectify. Even with your best efforts, it's likely there will be a couple of medium-size changes of direction/design that only become apparent in midcourse.

Use Your Team's Latent Talent

The most underutilized resources on most development projects are the programmers themselves! Often they are not allowed to discuss their own ideas with users or marketeers. Often they are pigeonholed into their one area and aren't even allowed to contribute to areas outside their own.

Ask discipline, professional work habits, and friendly interpersonal skills of your development team, and couch design and planning sessions in a consensus atmosphere that invites the best from everyone. Your team will then take the project closer to perfection than you guessed was possible. Emphasize the word *team*: what the team should value and aim for is what they can do together, not what any of them achieves individually.

A team-oriented consensus style is in strong contrast to concepts such as chief-programmer-based teams, for example, in which team members exist merely to make the guru chief programmer more efficient, implementing the designs that spring from his head. A benefit of inviting more contributions from team members is that their professional skills will develop more rapidly.

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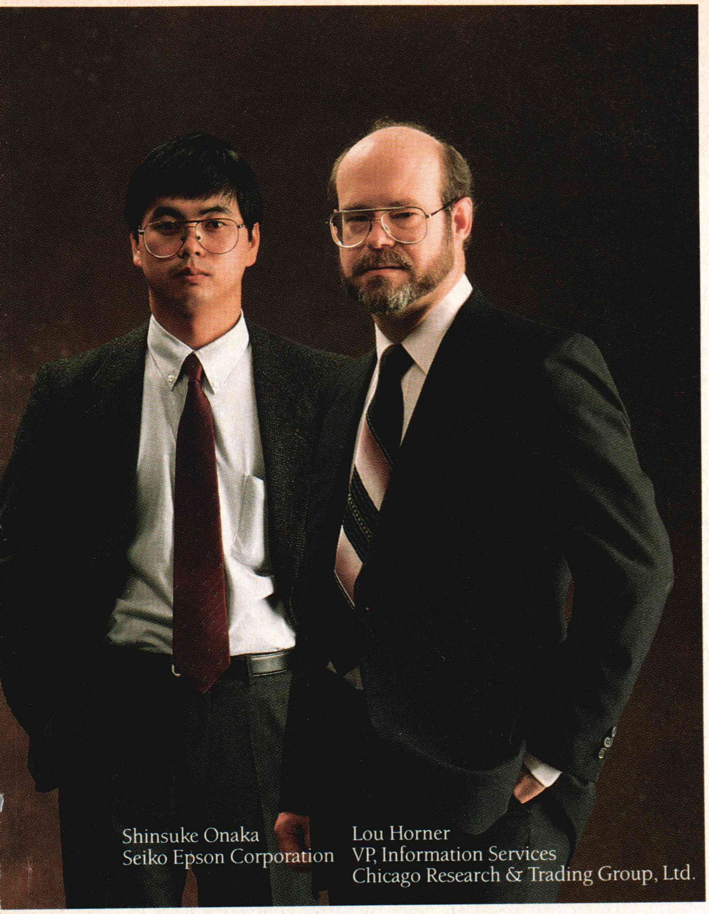

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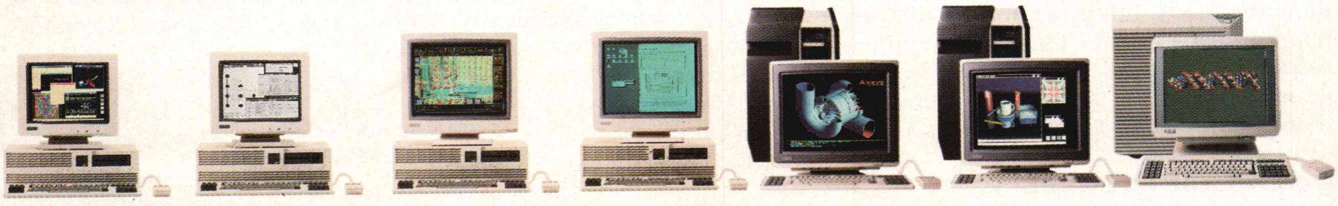

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DEVELOPING FOR THE USER
(continued from page 20)

Design and Develop Through Evolution

Once you have a clear understanding of your users' needs and your product design, you're ready to begin programming. It's key now to adapt an evolutionary implementation method that provides you with the flexibility to make changes as you learn from the growing product.

Some day there may be CASE tools that allow an entire product to be changed with ease, but for now the best way to obtain flexibility is to build from the outside in: begin building from the user interface inward and from your low-level building blocks upward. It's the middle levels of most software products that consume your implementation effort and are the hardest to change. For it is at these levels that functionality and behavior tend to be hard-wired into the architecture.

Low-level building blocks tend, on the other hand, to be understandable and flexible no matter what the flow and functionality of the higher levels. At the user-interface level, use scaffolding and other temporary crutches to get your user interface running. By doing so users can interact with the actual product itself, providing valuable polish and validation to your design.

If necessary you can prototype the user interface using prototyping tools such as Dan Bricklin's Demo program. Strive, however, to avoid using such tools for extensive mock-ups when you could spend your time developing the real code (with a little throwaway scaffolding).

Empathize with Users

If ease of learning is an important goal of your project, now is the time to sit a few users down and have them try to learn the system. Watch them yourself and have your programmers do the same (videotaping is a good method here). If three out of four subjects stumble at the same point, it's likely that area needs redesign. Such user testing can be both cheap and easy to perform. (If your market includes computer novices, for example, you can use relatives and friends as test subjects.)

A long-term benefit of having programmers and program designers talk with users and view user testing is that over time the programmers sharpen their "user empathy" skills. Over the course of a couple of projects, the programmers will develop user empathy—the ability to anticipate, during the design phase, many user problems your team will begin to get a reputation for being sharp user-interface designers.

Many programmers resist changes to their initial designs suggested by the marketing department or remote designers. But programmers who experience first-hand other humans having real difficulties tend to respond empathetically and are more motivated to iterate and perfect and polish the overall product for these users—all because their users are real to them.

Deliver the Product

It sounds obvious, but a far too common sin is not shipping the first version soon enough. In fact, some teams never ship "Version 1" but change and hack and perfect the product so long that they ship what can only be called Version 2.

Although sometimes justified by changing market conditions, waiting so long is usually a mistake. By shipping late you may miss a key market window or make your customers unhappy because they had to make do. If you'd shipped when you had a reasonable first version together, you may have released the product before any competitors did.

Support your product once it's shipping. Innovative products in particular need repeated explanation and selling from their designers. Ideally, your talks with users before ever building the product gave you a warm-up on explaining its special benefits.

Listen to Your Market

Despite your fervor in user testing and talking to users, there's no better way to get terrific feedback and guidance on evolving your product than shipping your product and then listening to the market.

Listen to your market by talking to the actual users of your product. Try to find a representative cross-sample of 15 to 25 users who you can talk to in the months after shipping. Question both beginning and advanced users of your product to get their reactions, but be sure to interrogate them again after a few months, when they've had time to plumb all the depths of your product.

Avoid the common mistake of releasing your software too often. Adequate testing and quality assurance at the end of a development project is expensive and often consumes four months. If you release a new version every ten months, you're testing four months for every six of developing. Furthermore, you have hardly any time to incorporate the expert users' feedback from your previous version. It's much better to adopt a 15-18-month cycle of releases, in which you have a full year or so of development for each testing phase. By adopting a discipline of following efficiently spaced releases, you can pull clearly ahead of your competition in features and functionality in just a couple of release cycles.

Reset to Phase One

The software delivery cycle is ideally one that loops repeatedly: Each of the eight phases is applied to every major product release, although some, such as selecting tools and building blocks, are obviously much abbreviated on later releases.

Developing for users is not easy. But it provides a methodology that helps you avoid costly errors that are surprisingly common: developing products that nobody wants; or that nobody can learn or use; or that don't meet enough user needs to make them pay money, which is after all what makes us professional developers.

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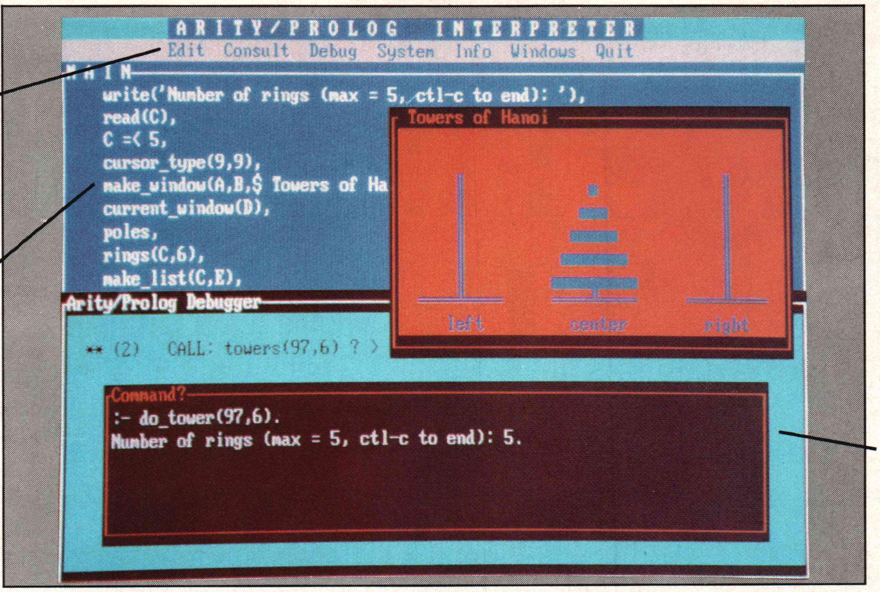

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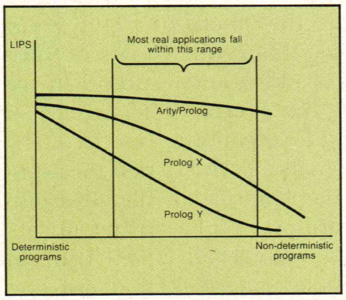

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```
:-public count_it/2:c('_count_it'(int,*int)).

count_it(Init,CountPtr):-
        count(init,Count),
        compute(int=*Countptr,
                *Countptr:=count).

count(100,_):-!,fail.
count(X,Y):-
       inc(X,Y).
count(X,Y):-
       count(X,Y)
```

You don't have to give up familiar tools, like C and Pascal, to take advantage of the power of Arity/Prolog. All C data types and expressions are integrated into Arity/Prolog V5. So you have a choice of using your existing C, Pascal, Fortran, or assembly code with Arity/Prolog V5, or including the declarative programming tasks as part of your Prolog program. And now you can call Arity/Prolog from your C function as well.

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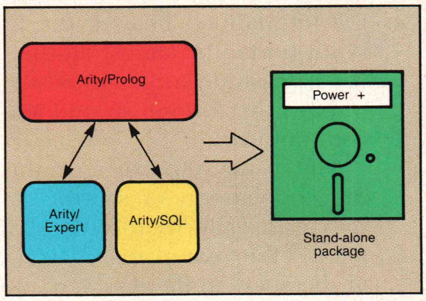

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Handling Image Files with TIFF

A picture may be worth more than 1,024 words but only if everyone can share the view.

by Anthony Meadow, Rocky Offner, and Michael Budiansky

It may sound categorical, but it's true: Anyone who is writing software that works with bit-mapped images should support the Tag Image File Format (TIFF). Why? Simply because TIFF has become the industry-standard format for storing bit-mapped images; the format is supported by almost all the desktop-publishing and scanner software in both the Macintosh and MS-DOS communities.

TIFF came into existence through the cooperation of several companies, especially Microsoft and Aldus. Many other companies have joined in the effort to develop and support this file format, including most of the scanner manufacturers (such as DEST Corp., Datacopy, and Hewlett-Packard) and the developers of desktop publishing software (Letraset, PS Publishing, and so on). The most recent version is Revision 4, released on April 31, 1987. Revision 5 is now under discussion and adds several important features.

The primary reason for the success of TIFF is the rapid rise of desktop publishing (DTP). DTP software and scanners became so popular that a way was needed to move images from scanners to publishing software. Initially, every scanner manufacturer developed a proprietary format for storing images, but it quickly became obvious that there was a better way to solve this problem. With the support of Aldus and Microsoft, TIFF became the alternative to supporting an odd collection of proprietary file formats. Fortunately, almost all scanner manufacturers decided to support TIFF, which has encouraged almost all developers of desktop-publishing software and paint programs to adopt TIFF, too.

Later in this article, we will describe the TIFF Library Package, which is now in the public domain. The package includes routines for reading and writing TIFF files, a sample application that uses them, and a utility program for examining TIFF files. Also included is a set of TIFF files that most TIFF implementations should be able to read. This set of files was designed to serve as an initial validation suite for TIFF implementations. You can write or call for the full package—the details are at the end of this article.

Anthony Meadow, Rocky Offner, and Michael Budiansky form the developer nucleus of Bear River Associates Inc., P.O. Box 1900, Berkeley, CA 94701.

What Can TIFF Do?

TIFF has satisfied many developers because it is capable of storing all the details about an image, which is not surprising because TIFF was developed as a superset of several existing proprietary formats.

TIFF is unlike most other file formats in that most information is not stored in fixed locations in the file. There are only 8 bytes of information in a TIFF file that have a specified location—the first 8 bytes in the file. Everything else is reached by using offsets from the start of the file. The categories of information that are currently supported seem to be sufficient for almost all applications today. If these categories are not sufficient, then others can be easily added. In fact, even proprietary information can be stored in a TIFF file without violating the specification.

Bit maps of any kind can be stored in a TIFF file—bilevel, grayscale, and color are all supported in Revision 5 of the TIFF standard. Images of any resolution, size, number of samples per pixel, and so on can be stored in TIFF files. These images might come from any kind of device, including scanners, facsimile machines, video frame stores, and so on, or from any kind of software that

can create a bit-mapped image.

TIFF is not supposed to be the only graphics file format. It may not provide sufficient capabilities for all bit-mapped graphics applications, although it's difficult to imagine what the exceptions might be. It does not provide support for object-oriented graphics, whereby images are composed of ellipses, rectangles, splines, and so on (as in Adobe Illustrator, MacDraw, or AutoCAD). TIFF also does not support PostScript or any other page-description language. The PICT and PICT2 formats supported by the Macintosh provide much of the functionality of TIFF with respect to bit maps and much more functionality to support object-oriented graphics and PostScript, but these file formats are proprietary. Table 1, below, compares TIFF with these and other file formats.

The Structure

The TIFF file structure is defined in a specification that is available from Microsoft or with the TIFF Library Package. Revision 4 is the latest, but Revision 5 is now in the works and adds conformance levels, a compression method for color and gray-scale images, and support for a "palette" type of color.

The obvious place to start learning about the TIFF file structure is to read the specification. After that, try dumping several TIFF files with td, the dump utility provided as part of the TIFF Library Package. Look at a variety of files in order to see what you can do with this format. The TIFF Library Package includes about two dozen files that show a wide variety of legal TIFF files.

Abbreviation	Name	Machines on which the format is supported				Support for				
		Mac	MSDOS	Unix	Other	Bilevel Bit Maps	Gray-Scale Bit Maps	Color Bit Maps	O-O Graphics	PostScript
TIFF	Tag Image File Format	Y	Y	Y	Y	Y	Y	Y	N	N
EPS	Encapsulated PostScript	Y	Y	Y	Y	Y[1]	Y[1]	Y[1,2]	Y	Y
PICT	(Macintosh) PICT	Y	N	N	N	Y	N	N	Y	Y[4]
PICT2	(Macintosh) PICT2	Y[3]	N	N	N	Y	Y	Y	Y	Y[4]
RIFF	Raster Image File Format	Y	N	N	N	Y	Y	Y	N	N
MacPaint	(Macintosh) MacPaint	Y	N	N	N	Y[5]	N	N	N	N

O-O graphics means object-oriented graphics (such as MacDraw).

Notes:
1–Bit-maps are supported, but not encouraged. Because EPS files are usually ASCII and not binary in form, bit-maps appear as large runs of digits.
2–Support for color in PostScript will improve when more color printers are available.
3–The PICT2 format is supported only on the Macintosh II at this time.
4–Support for PostScript in PICT and PICT2 files is through the use of special comments, so few applications can do anything with the PostScript commands directly.
5–MacPaint files are always 72 dpi and the maximum document size is 8 × 10 inches.

Table 1: *Comparison of image file formats*

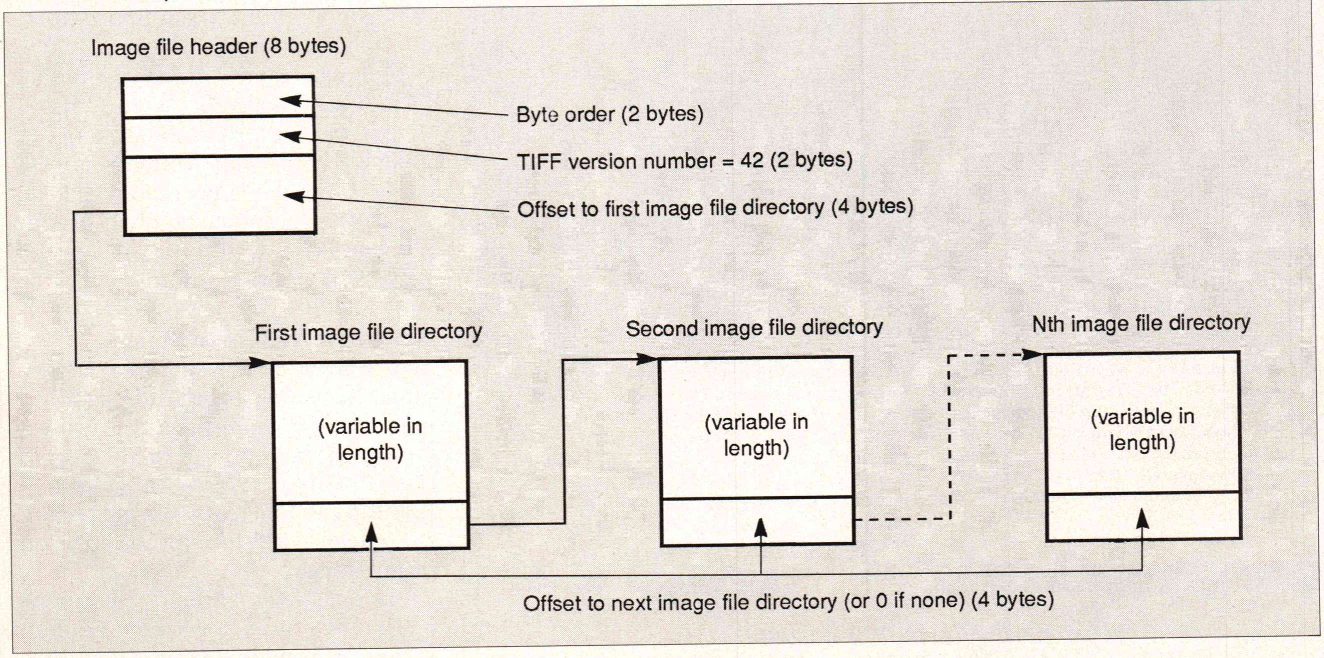

Figure 1: *Structure of a TIFF file*

(continued from page 27)

A TIFF file is composed of three kinds of elements: an image file header, one or more image field directories, and collections of data. Figure 1, page 27, shows the general structure of a TIFF file. The image file header (IFH) always occupies the first 8 bytes in a TIFF file and is the only element that has a fixed position within the file. The image file header contains the byte order flag, the file version number (currently 42), and an offset to the first image file directory (IFD).

All elements other than the IFH have variable positions within the file and are located by using byte offsets from the start of file. A TIFF file is considered to be a continuous sequence of (8-bit) bytes numbered from 0. The largest a TIFF file can be is 232 bytes long, or about 4 Gbytes.

The TIFF specification, like most other specifications, is not especially easy to read. One misunderstanding that we've seen several times concerns the location of various components of the file. The first image file directory is not necessarily just after the image file header—it might be anywhere in the file. Its location is given in the image file header.

A TIFF file may include multiple versions of an image—for example, it might be useful to provide a lower-resolution screen version of a 300-dpi image (to present on a screen), especially if an optimized scaling algorithm was used to generate the lower-resolution version. Of course, an application would have to look for the lower-resolution version and display it rather than generate one on the fly from the 300-dpi version. As far as we know, there are no applications that write more than one version of an image to a file, perhaps because of the additional disk space required. At any rate, if there are multiple versions of an image, then each version is described by the information in its image file directory. Each IFD contains an offset to the next IFD or 0 if there isn't another one.

Even though it is legal to write an image as a single strip, virtually all applications write images as a set of strips

Directories and Tags

Before we look at what an IFD contains, let's look briefly at tags and tag entries. A tag entry is basically a chunk of data (or a field) with a name (or tag). A tag entry might point to the image, the image height, the image width, or the orientation of the image.

An image file directory contains all the tag entries for a version of an image, ordered by tag type. Figure 2, page 32, shows what an IFD looks

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like. Only one tag of each tag type is allowed in an IFD.

As shown in Figure 3, below, each tag is 12 bytes long, where the first 2 bytes are the tag type. There are almost 40 tag types, which are defined in the specification. You can use other tags, but you should contact the TIFF administrator at Microsoft first. It's important to reserve any nonspecified tags so that there won't be any conflicts with files created by other applications. The address of the administrator is given at the end of this article.

The next 2 bytes in the tag entry are the data type, and the next 4 bytes are the length (or count). Five data types are defined in the specification: *byte* (1-byte unsigned integer), *ASCII*, *short* (2-byte unsigned integer), *long* (4-byte unsigned integer), and *rational* (two *longs*—the first is the numerator of a fraction and the second is the denominator). The length field in the tag entry gives the length of the data for this tag in terms of the data type—for example, if the data has a length of 1 and is of type *long*, then the data is 4 bytes long. By using the information in these two fields, you know exactly how much data there is for this tag.

The last 4 bytes in the tag entry are either an offset to the data or, if the data occupies 4 bytes or less, the data itself. If the data is less than 4 bytes in size, then it is left-justified within the 4 bytes. This convention for the Offset field optimizes access to small chunks of information, although it does make the file structure more complex.

Stripped Data

Images in TIFF files are usually divided into strips to allow for the memory limitations of most machines. A strip is typically an integral number of scan lines (a scan line is usually a horizontal row). Most applications cannot fit an entire image in memory at one time—for example, an $8^1/_2 \times 11$-inch bilevel image at 300×300 dpi requires more than 1 Mbyte of space. Most Macintoshes don't have this much space available, and most PCs don't have more than 640K of memory to start with.

Even though it is legal to write an image as a single strip, virtually all applications write images as a set of strips, where one strip typically is less than 64K in size. This allows applications to work with images using less memory than would otherwise be needed, although if enough memory is available, an application could still read a complete image into memory. When an image is divided into strips, the strips are either all compressed or all not compressed. The TIFF specification does allow you to compress some strips but not all.

The *StripOffsets* tag entry, as the name implies, contains offsets to the image data and not to the image. Each offset points to one image strip. This is true whether the image is composed of a single strip or many strips. These offsets are the only way to get to the image.

Gray-scale images are stored with all the bits for each pixel packed contiguously. Color images can be stored with all bits per pixel packed together or with the bits describing each color (in the RGB color model) stored in separate planes. The tag *SamplesPerPixel* has a value of 1 for a bilevel or gray-scale image, but for a color picture with three planes, it will have a value of 3. The *PlanarConfiguration* tag tells you whether there is one image plane or several—for example, if a color image was stored as multiple planes, there is one plane for red, a second for green, and a third for blue.

Two other tags always present in TIFF files are *ImageWidth* and *ImageLength*; they contain the width and height of the image in pixels. Each of these is usually 2 bytes long (although a program should always check the Data Type field in the tag entry to find out how long a field really is). For these two tags, the data is actually kept in the Offset field of the tag entry, rather than

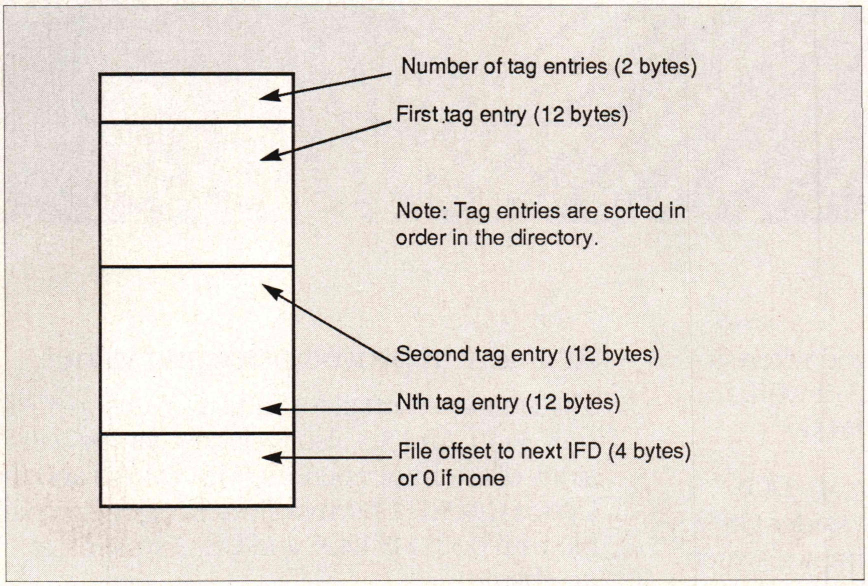

Figure 2: *Structure of an image file directory*

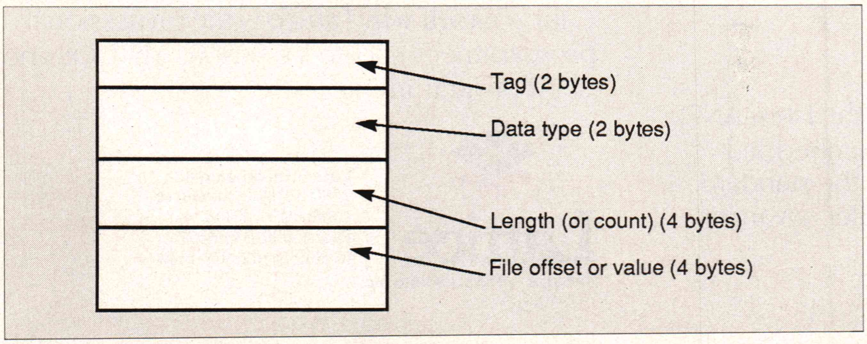

Figure 3: *Structure of a tag entry*

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TIFF
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being pointed to by a file offset.

Compressing Images

Image files are large compared with the average word-processing or spreadsheet document. Now that gray-scale scanners are on the market (and color scanners can't be too far away either), image files could become much larger. Table 2, this page, gives the size of various images at different resolutions. In order to conserve users' disk space, applications should compress images.

Revision 4 of the TIFF standard specifies several compression schemes for bilevel images. Revision 5 adds a method for compression of color and gray-scale. (The compression methods defined in Revision 5 are listed in Table 3, below.) Each of these methods is lossless—that is, each preserves all information in the image. Compression methods are possible that produce much higher compression ratios, but they do not save all of the image's information. These methods could be supported in a TIFF file, but no one has seen the need for them yet. An application needs to support only one compression method when writing each type of image (bilevel, gray-scale, or color) but should be able to read an image in any of the other compression methods.

The default compression method in the specification isn't really compression; it's simply packing data into bytes as tightly as possible. One of the other methods is a variation on this, where the data is packed into (16-bit) words as tightly as possible.

The compression methods for bilevel images are derived from the CCITT (International Telegraph and Telephone Consultative Committee) standards developed for facsimile machines. These methods are based on a Huffman run-length code. The CCITT arrived at the code by looking at samples of typical documents sent by facsimile. It's quite likely that images used in desktop publishing are not like the documents used in developing the CCITT standards, so the compression methods are probably not optimal. They aren't too bad, however; a compression ratio of 4 to 1 is typical. The TIFF standard allows for additional

Resolution* (dpi)	Bits/Pixel 1	4	8	12	24
72	61	242	485	727	1,454
150	263	1,052	2,104	3,156	6,311
300	1,052	4,208	8,415	12,623	25,245
600	4,208	16,830	33,660	50,490	100,980
1,200	16,830	67,320	134,640	201,960	403,920

* Assumes that all images are 8.5 × 11 inches in size
** Assumes that the horizontal and vertical resolution are the same

Table 2: *Sizes of uncompressed bit-mapped images** (K)*

Tag Value	Name
1	None (but pack data into bytes tightly)
2	CCITT Group 3 1-Dimensional modified Huffman run length encoding
3	Facsimile-compatible CCITT Group 3
4	Facsimile-compatible CCITT Group 4
5	Differential run-length encoding
32771	None (same as 1 except pack tightly into words)
32773	PackBits compression

Table 3: *Compression methods in TIFF, Revision 5*

TIFF

(continued from page 35)

compression schemes in the future, but the TIFF file I/O code will have to be revised in all applications so that they can read files that use these new compression methods.

Why Use TIFF?

The most obvious reason to use TIFF is that everyone (well, almost everyone) already does. If you are writing an application that works with bit-mapped images, it can work with all the existing applications that already produce or read TIFF files. If you develop a proprietary file format, you will have to talk many others into supporting it.

The richness of the file structure has caused a couple of other problems.

Another advantage of TIFF is that it was designed to support changes easily. By using new tags, additional information can be added to TIFF files. Older applications won't be able to take advantage of the information in the new tags, but as long as the information they need is there, they can still use the file. Hopefully you won't require any new tags because TIFF already provides a rich set. The kind of information that TIFF supports is a superset of virtually all that contained in proprietary image file formats.

It's also possible to store proprietary information in a TIFF file. The tags numbered 32,768 to 65,535 are reserved for this purpose. Developers who would like one or more tags reserved should contact the TIFF administrator at Microsoft. Obviously, only applications "in the know" are able to use such proprietary information.

Portability of data is becoming more and more important these days. It's now common to see Macs and PCs connected over a local-area network. TIFF supports portability of data because both the Motorola and Intel differences are clearly defined and can therefore be handled easily by an application. TIFF files can also be easily moved to almost any other file system because TIFF makes no assumptions about the underlying file system.

Problems with TIFF

TIFF does have a few problems, but as the standard evolves, many of them are being solved.

The TIFF file structure is not simple—it is more complex than many existing proprietary file formats, such as MacPaint's. This complexity costs time in several ways—for example, there is more overhead to write a TIFF file than a file with a simpler format. It also takes longer to write the TIFF I/O functions for an application because of TIFF's generality, although the library described in this article will reduce this development time for Macintosh developers. There are also TIFF toolkits available from others for MS-DOS machines.

The richness of the file structure has caused a couple of other problems. The TIFF standard (until Revision 5) did not specify a minimal set of tags, so each developer has used a different subset of tags in his or her files. This problem should be solved in Revision 5 of the standard, which specifies six conformance levels. Each level is specified by listing which tags and compression methods must be supported. Hopefully all developers will make the (few) changes in future revisions of their products to bring them to a reasonable conformance level.

Table 4, page 39, outlines the features of the various conformance levels. The FAX conformance level is in a different category from the others because the features required to support facsimile machines are special. An application that supports level 3 and FAX is described as conforming to level 3 + FAX.

Another problem is that there are no compression schemes for color and gray-scale images. An 8.5 × 11-

inch gray-scale image with 8 bits per pixel at 300-dpi resolution requires 8.4 Mbytes of storage without compression. Even people with hard disks would quickly run out of room without some form of compression for these images. This problem is also being solved in Revision 5 of the TIFF standard, which details a compression method for both color and gray-scale.

Tools from the Library

Necessity is the mother of invention. The TIFF Library Package was created as part of DEST Corp.'s product Publish Pac, which is a Macintosh application that lets users operate one of DEST's scanners to read in images and text. (There is also a version of Publish Pac for the IBM PC.) DEST was an early adopter of TIFF; it decided to use TIFF as its standard file format rather than develop yet another proprietary format. The TIFF Library Package is used by Publish Pac to read and write TIFF files. In its current state, it is used in the latest version of Publish Pac. It is written in MPW C (from Apple's Macintosh Programmer's Workshop) and could be ported to other versions of C on the Macintosh with little trouble.

The TIFF Library Package provides low-level routines for working with TIFF files. These routines provide a standard way to read and write TIFF files as well as to manage TIFF tags. The TIFF file format requires a certain amount of bookkeeping, such as ordering all tags sequentially. The library routines handle this automatically to ensure that all images are consistent with the specification. If you use this library, you won't have to learn all the low-level details of what TIFF files look like, but you will still have to decide which tags you want to read and write. The library includes routines to read and write the TIFF header, read and write the tags as a group, and read and write images. Table 5, page 43, contains a list of all the function names.

Reading and writing the file header is straightforward. The two routines *TReadHeader* and *TWriteHeader* read and write the TIFF file header, which contains the byte ordering of the file (Motorola or Intel) and the offset of the first image file directory. If the byte ordering is different from the native ordering, the offset to the directory and all subsequent numerical values are adjusted before they are returned, so an application doesn't have to know whether the file originated on a Macintosh or a PC.

To facilitate tag handling, an in-memory, tag-management scheme was designed so that all tags and their values are read from the file into memory. From there the tags and their values can easily be located, modified, and removed, and new tags can be inserted with simple function calls. When reading a TIFF file, call *TReadTags* to get all the tags into memory at once. You can then make function calls to check for the presence of a tag or get a tag's value.

When you're ready to create a TIFF file, make calls to create or

modify the appropriate tags. The position of the tags and the method for storing the values according to the TIFF specification is handled by the library routines. A call to *TPutPtrTag* or *TPutHdlTag* is made for each tag that's being added to the TIFF file, with two exceptions. The *StripOffsets* and *StripBytesCounts* tags are created and updated automatically by the routine that writes the image strips to the file. Calls to *TWriteTags* include a pointer to the tag's value, and the tag is included in the in-memory tag list.

To write an image to a file, an application makes one call to *TWriteImageStrip* for each strip that will be in the TIFF file. Each strip must have a number of rows less than or equal to that specified by the *RowsPerStrip* tag. Reading an image from a file is a bit more flexible. Any number of rows can be requested by using the *TReadImage* function starting with any row, regardless of the number of rows per strip.

Two auxiliary routines, *TFixOddRowBytes* and *TUnfixOddRowBytes*, provide image adjustment. Using compression method 1, the bits of each row of an image are stored in the smallest possible number of bytes. Some systems normally fit the bits into the smallest number of (16-bit) words—for example, in the Macintosh operating system, bit

Level	Name	Byte Order Supported	No. of Images (IFDs) per File	No. of Tags That Must Be Supported	Bilevel Compression Methods	Gray-Scale Compression Methods	Color Compression Methods
1	Bilevel images with simple compression	Native	1	6	1, 32773	N/A	N/A
2	Rich bilevel images with CCITT compression	Both	1	10	1, 2, 32771, 32773	N/A	N/A
3	Compressed gray-scale images	Both	1	16	1, 2, 32771, 32773	1, 5, 32771	N/A
4	Compressed color images	Both	1	18	1, 2, 32771, 32773	1, 5, 32771	1, 5, 32771
FAX	Bilevel facsimile data	Both	Many	13	1, 2, 3, 4, 32771, 32773	N/A	N/A
5	Unlimited support	Both	Many	37	All defined	All defined	All defined

Table 4: *Conformance levels in TIFF, Revision 5*

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(continued from page 39)

maps are always an even number of bytes in length. These auxiliary routines are provided to translate the image between these two storage methods if the bits in a row of an image can fit in an odd number of bytes.

The current TIFF Library Package supports most of the first and second conformance levels. Only compression methods 1 (tight packing into bytes) and 2 (modified Huffman run-length encoding) are supported at this time. Also, only the default orientation is supported, where the 0th row represents the top of the image and the 0th column represents the left side of the image (there are seven other possible orientations). When Revision 5 of the TIFF specification is released, the package will probably be upgraded to meet conformance level 3.

The Sample Program

The sample program demonstrates how to use the routines in the Macintosh version of the TIFF Library Package. The program is limited in its ability to display images or read in complex nonbilevel TIFF images, but it does use most of the functions in the library. It can read and write TIFF files and will let you cut and paste Macintosh PICT images to and from the Clipboard—for example, a drawing can be made in MacPaint, cut or copied into the Clipboard, and then pasted into the sample program and written out to a TIFF file. Similarly, a TIFF image can be read into the program, copied into the Clipboard, and pasted into other programs such as MacPaint.

Listing One, page 54, shows two functions—*ReadTiff* and *WriteTiff*—from the sample program. We will now use them to demonstrate the use of the library functions.

The ReadTiff Function

The *ReadTiff* function shows how to use the TIFF library routines to read a TIFF file. First, you read the file header using *TReadHeader*, and then you read all the tags into memory using the *TReadTags* function.

Subsequently, local data structures are filled with the values of the tags via calls to the tag-management routines *TFindTag* and *TGetTag*. If a tag is present, then the value is set; if not and the tag has a default value, the local data for that item is set to the default. If there is no default for a tag, then you either ignore that value or report an error if the tag is necessary.

Once the tag values have been obtained, you determine if there are any values that require facilities beyond those provided to display this image. If so, an error is reported. Once you've determined that the image as described by the tags is correct and that you are able to display that image, a call to *TReadImage* is made. The sample program requests the lines of the image from line 0 through the number of rows in the entire image or the number of rows that will fit into 32K of memory, whichever is smaller. If you successfully read the image, then it (or some portion of it) is displayed in a simple window.

The WriteTiff function

The *WriteTiff* function demonstrates how to write a TIFF file using functions from the TIFF library. A subset of the available tags is placed in the tag list using the *TPutPtrTag* function. The tags specified are those required by the specification plus a couple of others that, although not required by the TIFF specification, are quite useful.

After placing all the tags you want in the tag list, the strips are written

File-handling functions
- TReadHeader
- TWriteHeader
- TReadTags
- TWriteTags
- TReadImage
- TWriteImageStrip

Tag list management functions
- TFindTag
- TGetTag
- TPutPtrTag
- TPutHdlTag

Auxiliary functions
- TFixOddRowBytes
- TUnfixOddRowBytes

Table 5: *TIFF Library Package functions*

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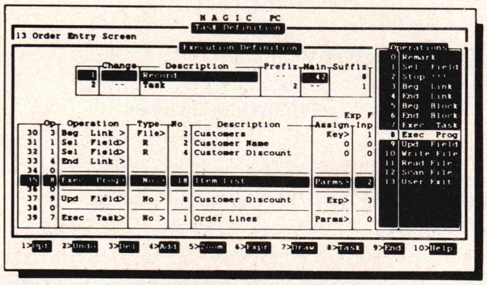

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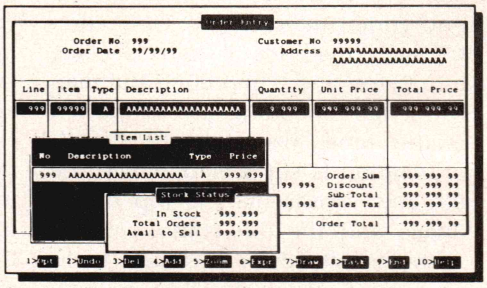

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TIFF
(continued from page 43)

to the file using the *TWriteImageStrip* function. The number of rows per strip (8) used by the sample program is an arbitrary value chosen to demonstrate how to write multiple strips. The *RowsPerStrip* tag can be set to any value the creator desires, although it is a good idea not to let strips get too big. For the Macintosh, it is wise to limit strips to no more than 32K.

Once all the strips have been written, the tags are flushed to the file by a call to *TWriteTags*. Finally, the header is written using *TWriteHeader*. After the file has been closed and flushed to disk, you've created a TIFF file.

Conclusion

The TIFF file format has become popular in both the Macintosh and MS-DOS worlds. It offers a way to share any kind of bit-mapped image with a large and growing number of other applications. Anyone who is writing software that works with bit maps should support TIFF. The TIFF Library Package described in this article will help any Macintosh programmer read and write TIFF files with a minimum of work. It can also be ported to other machines.

Availability

Because of the size of the TIFF Library Package (close to 1 Mbyte), we've been forced to forego the usual distribution method of printing the listings in the magazine or putting them on CompuServe. Serious developers and readers of *DDJ* can, however, receive a free set of disks for the TIFF Library Package by mentioning this article in a request to one of two sources.

For a copy of the TIFF Library Package for the Macintosh, send your name and address to Bear River Associates Inc., Attn: TIFF, P.O. Box 1900, Berkeley, CA 94701 or call 415-644-9400 (9 A.M. to 5 P.M. PST) and ask for the TIFF Library Package.

A similar TIFF package is available for the PC. To get this package, write to DEST Corp., Attn.: Debra Levesque, 1201 Cadillac Ct., Milpitas, CA 95035 or call 408-946-7100 and ask for Debra Levesque.

To receive a copy of the latest version of the TIFF standard, to reserve a proprietary tag, or to comment on the standard, write to Manny Vellon, Windows Marketing Group, Microsoft Corp., 16011 N.E. 36th Wy., P.O. Box 97017, Redmond, WA 98073-9717.

Bibliography

Andrews, Nancy; and Fry, Stan. "TIFF: An Emerging Standard for Exchanging Digitized Graphics Images." *Microsoft Systems Journal* (July 1987): 71–76.

DDJ

(Listing begins on page 54.)

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Circle Reader Service **No. 2.**

Virtual Arrays in C

The concept of virtual arrays is not new, but it can now be applied to microcomputers.

by Mark Tichenor

This article presents a virtual-array management scheme for C programmers. This simple and flexible approach uses the power of the C language to manipulate arrays that extend themselves automatically and that are limited in size only by the file-size constraints of the operating system. The concept of virtual arrays is not new, but it can now be applied to microcomputers.

Highlights of the scheme are:

- Virtual arrays are stored on disk but are accessed as though they are in memory.
- Automatic file management is provided without explicit reads or writes.
- Disk records can be accessed simply by referencing an array element in any C expression.
- Data can be written to any record in the file simply by using an assignment statement to place a value in an array element.

The Problem

Many problems lend themselves naturally to simple solutions based on the use of data arrays because arrays are easy to manipulate using simple notation. Data arrays can only be as big as available memory allows, however. This is an aggravating limitation because, once arrays outgrow available memory, they are no longer useful.

In implementing an application prototype involving complex tree structures, I chose an array approach using data arrays that incorporated pointers. These pointers were the array indices of other array elements. As the application provided the means to manage a growing volume of information, it was necessary to overcome the memory limitation imposed by the array model.

A lot of thought went into solutions based on dynamic memory allocation of data structures as this approach appeared to promise an elegant and general solution. The need to swap data between memory and disk still remained, however. In fact a whole new problem arose: that of resolving the differences between pointers in memory and pointers on disk.

When dynamically allocated data structures are linked by memory pointers, these pointers become meaningless when written to disk. The linkages must be recreated when the structures are brought back into memory. This problem dramatically increases the complexity of any program that incorporates the swapping of data between memory and disk.

It would be a great advantage to keep using data arrays if their size were not limited by available memory.

The Solution

The memory limitation associated with arrays can be overcome by using virtual arrays that are stored on disk and accessed as though they were in memory. Thus, virtual arrays offer a simple, elegant solution. The C programming language provides the power to manage virtual arrays automatically through the creative use of pointer notation and *#define* macros.

It turns out that virtual-array elements can be accessed by simple reference using a predefined alias and an array index—for example, *item_number(i) = 5;* could be used to set the *item_number* field of the *i*th array element to the value *5*.

Because virtual arrays reside on disk, with paging to memory automatically accomplished behind the scenes, you have a disk-based data management system that operates without any explicit reads or writes. These operations are performed by the virtual-array access function, which is invoked by the predefined access macros.

Mark Tichenor is an instructor in the Business Information Processing Dept., Holland College, Charlottetown Centre, Weymouth St., Charlottetown, PE C1A 4Z1, Canada. He is currently developing interactive software design tools.

The Code

Listing One, page 63, contains the virtual-array header file, and Listing Two, page 63, contains the virtual-array access routines. Four C functions handle all the mechanics of managing the virtual arrays.

The Initialization Routine

```
int init_v_array(filename,
                 record_size, filchar)
char *filename, filchar;
int record_size;
```

Init_v_array creates a new virtual-array file named by filename. File headers are written initializing the record size of the file to *record_size* and setting the number of records to 0. The specified fill character is also placed in the file header for later use in initializing new array elements. The file is then closed. This routine returns a value of 1 if successful, 0 if not.

An example is:

```
if (init_v_array("DATA.VAR",128))
        printf("Success!");
```

which will try to create a new virtual array named *"DATA.VAR"* with elements 128 bytes long and will print a message if successful.

The Open Routine

```
VACB *open_v_array(filename,
                   buffer_size)
char *filename;
int buffer_size;
```

open_v_array prepares an existing virtual array for use. *buffer_size* specifies how many array elements to allocate space for in memory. The routine returns *NULL* if unsuccessful; otherwise, it returns a pointer to the created virtual-array control block (*VACB*).

An example is:

```
VACB *item array;
item_array =
    open_v_array("DATA.VAR",100);
```

which opens the *"DATA.VAR"* array file and reserves enough buffer space for 100 array elements.

The Close Routine

```
void close_v_array(array)
VACB *array;
```

close_v_array writes elements from buffer to disk, closes the array file, and frees allocated memory.

An example is:

```
close_v_array(item_array);
```

The Access Routine

```
void *access_v_array(array,index)
VACB *array;
long index;
```

This routine performs the low-level file management for virtual arrays. It makes sure the array element referenced by *index* is in memory and returns a pointer to it in memory. If the specified array element is already in memory, access is immediate; if not, it is read into memory after saving the record it displaces in the buffer. If the referenced array element does not exist, the routine automatically extends the *array* file so that it does.

For an example, see the listings and the section entitled "Access Notation."

The Access Algorithm

The key to easy reference to array elements (or to fields within them) is the *access_v_rec* function. This function returns a *void* pointer to the location of the element in memory after making sure it is there.

In the interests of demonstrating the feasibility of this approach quickly, I have paid no regard to optimization. The only stipulation was that access to array elements already in memory be as fast as possible.

To meet this requirement, I chose a simple modulus buffering scheme. Each array element has a fixed position in the buffer calculated by element number modulus buffer size. Each element in the buffer is prefixed with a *long* array index containing the number of the element

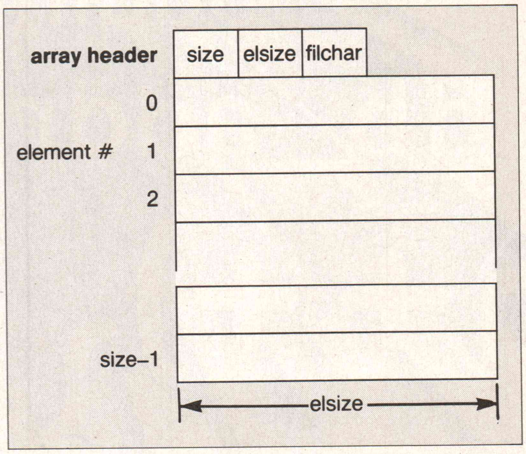

Figure 1: *Virtual-array file layout*

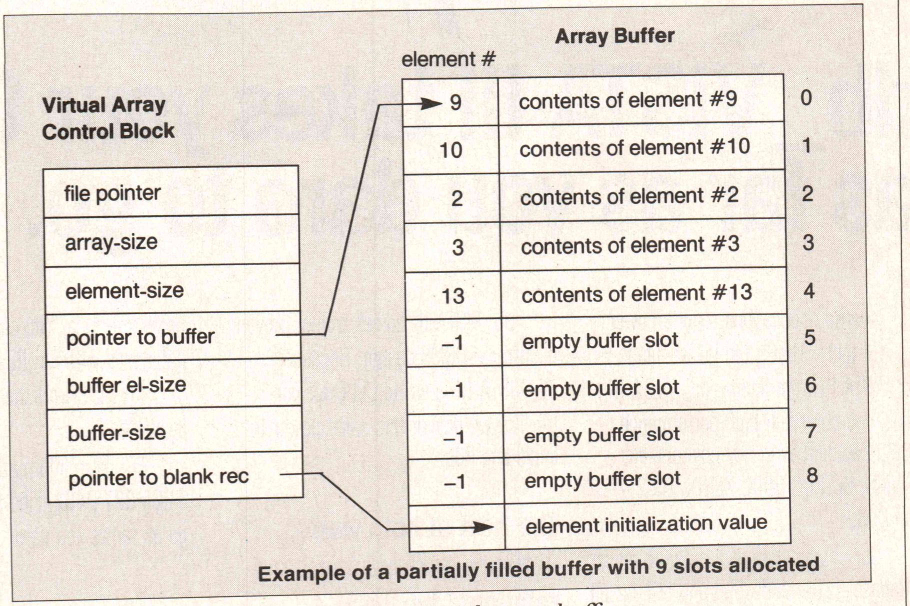

Figure 2: *Virtual-array control block and array buffer*

VIRTUAL ARRAYS
(continued from page 47)

currently present or a –1 if no element is in that buffer position.

If the referenced array index does not match the index of the element currently occupying the calculated buffer location, that array element in the buffer (if any) is written to disk and the referenced element is read in before the buffer address is returned. This scheme avoids searching for records in memory.

Cautions

You should use only *long* integer indices to access array elements. Be sure to *#include* <varray.h>.

Take care not to overrun the end of the array elements when copying strings into them.

You should also take care not to accidentally reference array items far beyond the end of the array unless you really intend to do so. When an array element beyond the end of the array (that is, it does not exist) is referenced, the access routine automatically extends the file so that the referenced element does exist. This process can cause a lot of disk activity and take considerable time because all the elements from the end of the array up to the referenced element must be initialized and written to disk.

Memory copy functions, such as *strcpy*, used to copy data directly from one array element to another are unreliable because the two may occupy the same buffer location. For example:

```
strcpy(desc(n),desc(m));
```

will not work when *n modulus buffer_size* equals *m modulus buffer_size*. However:

```
qty(n) = qty(m) + 1;
```

will work because memory copying is not invoked. (This is true because the compiler calculates the assignment value before it calculates the address for assignment.)

To avoid buffer collision, use:

```
strcpy(temp_desc,desc(m));
strcpy(desc(n),temp_desc);
```

The buffer collision problem associated with the simple modulus buffering scheme could be avoided with the development of a robust least recently used buffering scheme.

Buffered access of any kind also precludes the use of such things as in-memory sort utilities (for example, *qsort*).

Take care not to overrun the end of the array elements when copying strings into them. This would corrupt the index information in the next buffer slot, with unpredictable (probably bad) results.

Access Notation

#define statements are used to simplify access notation both to array elements and to fields within them. One #define is required for each virtual array used. Optionally, one #define may be used to simplify access to each field within a virtual array of structures. Alternately, pointer notation may be used to access fields.

In the example program in Listing Three, page 66:

```
#define VREC(i) ((items *)
      access_v_rec(item_array,i))
```

sets up easy access to elements in the virtual array called item_array (stored in *"ITEMS.VAR"*). In this example, *(items *)* casts the *void* pointer returned by *access_v_rec* to the type *pointer to items*, where *items* is the defined type of the virtual-array element structure. *item_array* is the virtual-array handle returned by *open_v_array*.

In use, *VREC(i)* returns a memory pointer to the *i*th array element wherever it is in the virtual-array buffer. **VREC(i)* is a reference to the *i*th *items* structure in the array. It can

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VIRTUAL ARRAYS

(continued from page 49)

be used in any expression as a variable of type *items*.

The expression:

```
#define item(i) VREC(i)->v_item
```

in Listing Three sets up easy access to the *v_item* field in the *i*th element of the *item_array* virtual array. *item(i)* becomes its alias. This allows you to say:

```
item(i) = 24;
```

which is much more intuitive than:

```
((items *)
access_v_rec(item_array,i))->
                    v_item = 24;
```

This ease of reference is what makes this virtual-array system possible.

The size of a virtual array is always available because it is stored in the virtual-array control block. The expression:

```
i = item_array->size;
```

sets *i* to the current size of the virtual array referred to by *item_array*. You should never change this value but can refer to it to determine the index value to use in order to extend the array by one element. For example:

```
i = item_array->size;
item(i) = any_value;
```

will extend the array by one element.

Multidimension arrays are also possible; however, you can extend them only in one dimension. In the example program, the *v_desc* field is a character array that can be regarded as two dimensional when extended over the virtual array. Particular elements in the two-dimensional array can be referenced by *desc(y)[x]*, where *y* is the element number and *x* is the character number.

If you wished to formalize this two-dimensional access, you could add a new macro:

```
#define D(x,y) VREC(y)->v_desc[x]
```

(continued from page 51)

in which *D(x,y)* would refer to column *x*, row *y*. This construct is useful for creating very large virtual-display spaces that can be quickly mapped to the physical display to accomplish fast panning.

Using Virtual Arrays

1. Create a virtual-array file by calling *init__v__array* and passing it the DOS file name, the record length of array elements (in bytes), and a fill character for initializing new elements in the array as they are referenced. This creates a new file, overwriting any existing file of the same name, and writes out the array header information: 4 bytes for array size (initialized to 0), 2 bytes for the size of array elements, and 1 byte for the fill character. Perform this step only once.
2. Typedef your array element structure.
3. Define your array element access macro—for example:

```
#define VREC(i) ((items *)
        access__v__rec(item__array,i))
```

4. Define each field's access macro for the array.
5. Call *open__v__array*, passing it the file name and buffer size. This call must assign the return value to a variable of type *(VACB *)*. This must be the same variable name used in your array access macro—for example:

```
item__array =
    open__v__array("ITEMS.VAR",10);
```

6. Do whatever you want with your virtual array using the access macros you defined in steps 3 and 4.
7. Close your virtual array by calling *close__v__array* and passing it your virtual-array handle—for example, *close__ virtual__array(item__array);*.

Implementation

These routines were tested using Borland's Turbo C development system with both the large- and small-memory models. Using a standard 4.77-MHz PC-compatible with a cheap (slow) hard disk and MS-DOS 3.2, 200 records of 128 bytes each were swapped in 15 seconds and 200 4-byte records were swapped in less than 2 seconds. Though these access speeds may be slow for massive matrix multiplication, they are adequate for many data-access applications.

The beauty of this virtual-array system is that arrays are no longer limited by available memory and all the mechanics of file management take place automatically behind the scenes.

Availability

All the source code for articles in this issue is available on a single disk. To order, send $14.95 to *Dr. Dobb's Journal*, 501 Galveston Dr., Redwood City, CA 94063, or call (415) 366-3600, ext. 221. Please specify the issue number and format (MS-DOS, Macintosh, Kaypro).

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(Listings begin on page 63.)

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Listing One *(Text begins on page 26.)*

```
/* Primary Interface Files */
#include "Types.h"
#include "Quickdraw.h"
#include "Windows.h"

/* Other Interface files */
#include "Errors.h"
#include "Files.h"
#include "Memory.h"
#include "Packages.h"
#include "Scrap.h"

/* Application-specific Include files */
#include "::TiffLibrary:TIFFLib.h"
#include "sample.h"
#include "messages.h"

static Ptr  SetIDPtr();
static void CleanUp();
static void InitID();

#define     MAXIMAGESIZE    0x8000                          /* Limit images to 32K for now */
#define     INFINITY                        0x4000000       /* TIFF Spec says 2**32-1 but this is big enough */

/* Read in an image from a TIFF format file.  As the code demonstrates, we
 * do not read in very complicated images.  We read in a number of tags,
 * and reject the image as an unsuitable tiff file if any of several
 * conditions exist.  We do not read in images that have more than one bit
 * of image data per pixel.  Of those simple images that we do read, we
 * will only read the first 32k of that image.
 */
Boolean ReadTiff(refNum, myBitMapPtr)
Int16 refNum;
BitMap *myBitMapPtr;
{
            Handle                                          listH;
            Boolean                                         oddRowBytes;
            Int8                                            dummy;
            Int16                                           byteOrder,
                                                                    rowBytes,
                                                                    scrnHRes,
                                                                    scrnVRes;
            Int32                                           tagOffset,
                                                                    nextDirOffset,
                                                                    nextFileFree,   /* next free location in output file */
                                                                    dirOffset,
                                                                    rowsPerImage,
                                                                    count,
                                                                    size;
            Rational                        xRes,
                                                                    yRes;
            Rect                                            imageRect;
            TiffDirEntry    tagDirEntry;
            id                                                      id;                     /* image
description */

            InitID(&id);
            ScreenRes(&scrnHRes, &scrnVRes);                /* if needed for defaults */

            /*
             * Read in header and Tags
             */

            if (TReadHeader(refNum, &dirOffset, &byteOrder) != noErr) {
                        ErrorMessage(BADREADHEADER);
                        return(false);
            }

            if(TReadTags(refNum, byteOrder,
                                                            &listH, dirOffset, &nextDirOffset) != noErr) {
                        ErrorMessage(BADREADTAGS);
                        return(false);
            }

            /* Get tags values.
             */
            /* SUBFILE_TYPE_TAG */
            if (TFindTag(listH, &tagOffset, SUBFILE_TYPE_TAG))
                        TGetTag(listH, tagOffset, &id.subfileType, sizeof(id.subfileType));
            else {
                        ErrorMessage(BADTIFF);
                        CleanUp(listH, &id);
                        return(false);
            }
            /* IMAGE_WIDTH_TAG */
            if (TFindTag(listH, &tagOffset, IMAGE_WIDTH_TAG))
                        TGetTag(listH, tagOffset, &id.imageWidth, sizeof(id.imageWidth));
            else {
                        ErrorMessage(BADTIFF);
                        CleanUp(listH, &id);
                        return(false);
```

(continued on page 56)

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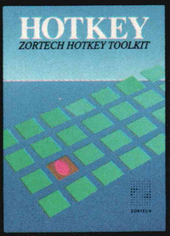

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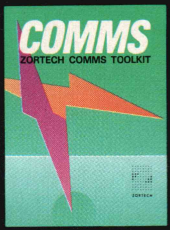

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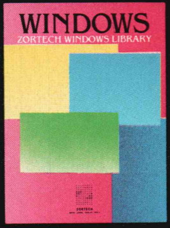

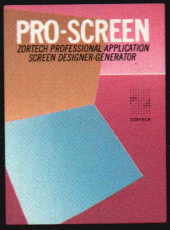

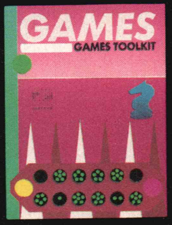

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Listing One *(Listing continued, text begins on page 26.)*

```
        }
        /* IMAGE_LENGTH_TAG */
        if (TFindTag(listH, &tagOffset, IMAGE_LENGTH_TAG))
                TGetTag(listH, tagOffset, &id.imageLength, sizeof(id.imageLength));
        else {
                ErrorMessage(BADTIFF);
                CleanUp(listH, &id);
                return(false);
        }
        /* ROWS_PER_STRIP_TAG */
        if (TFindTag(listH, &tagOffset, ROWS_PER_STRIP_TAG)) {
                TGetTag(listH, tagOffset, &id.rowsPerStrip, sizeof(id.rowsPerStrip));
                tagDirEntry = GetDirEntry(listH, tagOffset);
                switch(tagDirEntry.type) {
                case LONG:
                                break;
                case SHORT:     /* ok, but convert returned value */
                                id.rowsPerStrip = (long)( *((Int16 *)(&id.rowsPerStrip)) );
                                break;
                default:
                                ErrorMessage(BADTIFF);
                                CleanUp(listH, &id);
                                return(false);
                }
        }
        else {
                id.rowsPerStrip = INFINITY;
        }
        /* SAMPLES_PER_PIXEL_TAG */
        if (TFindTag(listH, &tagOffset, SAMPLES_PER_PIXEL_TAG))
                TGetTag(listH, tagOffset, &id.samplesPerPixel, sizeof(id.samplesPerPixel));
        else {
                id.samplesPerPixel = 1;
        }
        /* BITS_PER_SAMPLE_TAG */
        id.bitsPerSample = SetIDPtr(listH, BITS_PER_SAMPLE_TAG, 1L, SHORT);
        if (id.bitsPerSample == nil) {
                                CleanUp(listH, &id);
                                return(false);
        }
        /* PLANAR_CONFIG_TAG */
        if (TFindTag(listH, &tagOffset, PLANAR_CONFIG_TAG))
                TGetTag(listH, tagOffset, &id.planarConfig, sizeof(id.planarConfig));
        else
                id.planarConfig = 1;
        /* COMPRESSION_TAG */
        id.compression = SetIDPtr(listH, COMPRESSION_TAG, 1L, SHORT);
        if (id.compression == nil) {
                                CleanUp(listH, &id);
                                return(false);
        }
        /* MIN_SAMPLE_VALUE_TAG */
        id.minSampleValue = SetIDPtr(listH, MIN_SAMPLE_VALUE_TAG, 0L, SHORT);
        if (id.minSampleValue == nil) {
                                CleanUp(listH, &id);
                                return(false);
        }
        /* MAX_SAMPLE_VALUE_TAG */
        id.maxSampleValue = SetIDPtr(listH, MAX_SAMPLE_VALUE_TAG,
                                                                        (Int32)((1 <<
    *id.bitsPerSample) - 1), SHORT);
        if (id.maxSampleValue == nil) {
                                CleanUp(listH, &id);
                                return(false);
        }
        /* PHOTOMETRIC_INTERP_TAG */
        if (TFindTag(listH, &tagOffset, PHOTOMETRIC_INTERP_TAG))
                TGetTag(listH, tagOffset, &id.photoInterp, sizeof(id.photoInterp));
        else {
                id.photoInterp = 0;             /* assume mac photometric interpretation */
        }
        /* FILL_ORDER_TAG */
        if (TFindTag(listH, &tagOffset, FILL_ORDER_TAG))
                TGetTag(listH, tagOffset, &id.fillOrder, sizeof(id.fillOrder));
        else
                id.fillOrder = 1;
        /* ORIENTATION_TAG */
        if (TFindTag(listH, &tagOffset, ORIENTATION_TAG))
                TGetTag(listH, tagOffset, &id.orientation, sizeof(id.orientation));
        else
                id.orientation = 1;
        /* X_RESOLUTION_TAG */
        if (TFindTag(listH, &tagOffset, X_RESOLUTION_TAG))
                TGetTag(listH, tagOffset, &id.xResolution, sizeof(id.xResolution));
        else {
                id.xResolution.numerator = (Int32)scrnHRes;
                id.xResolution.denominator = 1;
        }
        /* Y_RESOLUTION_TAG */
        if (TFindTag(listH, &tagOffset, Y_RESOLUTION_TAG))
                TGetTag(listH, tagOffset, &id.yResolution, sizeof(id.yResolution));
```

(continued on page 59)

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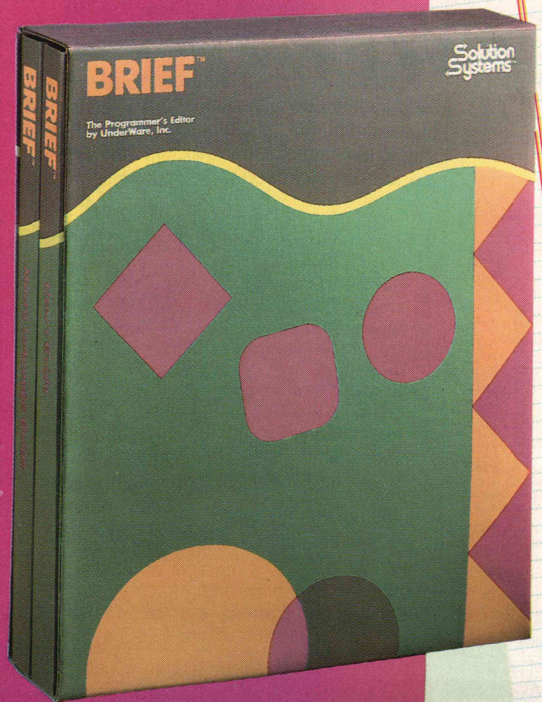

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Listing One *(Listing continued, text begins on page 26.)*

```
        else {
                    id.yResolution.numerator = (Int32)scrnVRes;
                    id.yResolution.denominator = 1;
        }

        /* Initialize of non-tag values.
         */
        oddRowBytes = (((id.imageWidth * (*id.bitsPerSample)) + 7) / 8) % 2 != 0;
        id.stripsPerImage =
                                        (id.imageLength + id.rowsPerStrip - 1) / id.rowsPerStrip;

        /*          Check Tag Values to see if we can read this TIFF file.
         *
         *          NOTE: Although the majority of the tag were read, all the values
         *          obtained are not used in displaying the image in THIS PROGRAM.
         *          Those not used were read in simply to provide the example.
         */
        if ( (id.samplesPerPixel != 1)                                              ||
                     (*id.bitsPerSample != 1)                                        ||
                     (id.planarConfig != 1 && id.planarConfig != 2) )          {
                    ErrorMessage(BADTIFF);
                    CleanUp(listH, &id);
                    return(false);
        }
        if (id.photoInterp != 0)        /* We don't translate yet so let 'em know */
                    ErrorMessage(BADPHOTOINTERP);

        rowBytes = (((id.imageWidth - 1) / (2 * 8)) + 1) * 2;
        /* only make image as much as will fit in MAXIMAGESIZE for now */
        size = id.imageLength * rowBytes;
        if (size > MAXIMAGESIZE) {
                    ErrorMessage(IMAGECROPWARN);
                    size = MAXIMAGESIZE;
        }
        rowsPerImage = size / rowBytes;

        /* Prepare bitmap.
         */
        if (myBitMapPtr->baseAddr != nil)
                    DisposPtr(myBitMapPtr->baseAddr);
        if ((myBitMapPtr->baseAddr = MyNewPtr(size)) == nil) {
                    CleanUp(listH, &id);
                    return(false);
        }
        myBitMapPtr->rowBytes = rowBytes;
        myBitMapPtr->bounds.top = 0;
        myBitMapPtr->bounds.left = 0;
        myBitMapPtr->bounds.bottom = rowsPerImage;
        myBitMapPtr->bounds.right = id.imageWidth;


        /* Read in image.
         */
        if (TReadImage(refNum, listH,
                                        0L, myBitMapPtr->baseAddr, rowsPerImage, -1) != noErr) {
                    CleanUp(listH, &id);
                    return(false);
        }
        if (oddRowBytes)
                    TFixOddRowBytes(myBitMapPtr);
        DisplayImage(FrontWindow(), myBitMapPtr);

        CleanUp(listH, &id);
        return(true);
}

void WriteTiff(refNum, myBitMapPtr)
Int16 refNum;
BitMap *myBitMapPtr;
{
        Handle                  listH;
        Ptr                                 bufferPtr;
        Boolean                 oddRowBytes;
        Int8                    dummy;
        Int16                   byteOrder,
                                            subfileType,
                                            imageWidth,
                                            imageLength,
                                            fillOrder,
                                            compressType,
                                            photoInterp,
                                            bitsPerPixel,
                                            minSampleValue,
                                            maxSampleValue,
                                            orientation,
                                            tiffRowBytes,   /* number of bytes per row in TIFF format */
                                            plane,                          /* dummy parameter for
TWriteImageStrip */
                                            scrnHRes,
                                            scrnVRes;
        Int32                   rowsPerStrip,
```

(continued on next page)

Listing One *(Listing continued, text begins on page 26.)*

```
                                                            nextFileFree,    /* next free location in output file */
                                                            startLine,
                                                            numLines,
                                                            dirOffset,
                                                            count;
          Rational        xRes,
                                                            yRes;
          Rect                          imageRect;

          /* get a handle for the in memory tag list */
          listH = NewHandle(0);
          if (MemError() != noErr) {
                          ErrorMessage(BADMEMORY);
                          return;
          }

          ScreenRes(&scrnHRes, &scrnVRes);
          imageRect = myBitMapPtr->bounds;
          /* write out 8 rows per strip - 8 is an arbitrary number */
          rowsPerStrip = MIN(imageRect.bottom - imageRect.top, 8);

          /* initialize tag values */
          byteOrder = MOTOROLA;
          subfileType = 1;
          imageWidth = imageRect.right;
          imageLength = imageRect.bottom;
          bitsPerPixel = 1;
          fillOrder = 1;
          compressType = 1;
          photoInterp = 0;
          minSampleValue = 0;
          maxSampleValue = (1 << bitsPerPixel) - 1;
          orientation = 1;
          xRes.numerator = (Int32)scrnHRes;
          xRes.denominator = 1;
          yRes.numerator = (Int32)scrnVRes;
          yRes.denominator = 1;

          tiffRowBytes = (imageRect.right * bitsPerPixel + 7) / 8;
          oddRowBytes = (tiffRowBytes % 2) != 0;

          /* Put tags in memory list.
           * The order tags are put in the list with TPutPtrTag is NOT important.
           */
          if (            TPutPtrTag(listH, SUBFILE_TYPE_TAG, SHORT,
                                                                                                      1L,
&subfileType)             != noErr        ||
                                          TPutPtrTag(listH, IMAGE_WIDTH_TAG,              SHORT,
                                                                                                      1L,
&imageWidth)              != noErr        ||
                                          TPutPtrTag(listH, IMAGE_LENGTH_TAG, SHORT,
                                                                                                      1L,
&imageLength)             != noErr        ||
                                          TPutPtrTag(listH, ROWS_PER_STRIP_TAG, LONG,
                                                                                                      1L,
&rowsPerStrip)            != noErr        ||
                                          TPutPtrTag(listH, X_RESOLUTION_TAG, RATIONAL,
                                                                                                      1L, &xRes)
          != noErr        ||
                                          TPutPtrTag(listH, Y_RESOLUTION_TAG, RATIONAL,
                                                                                                      1L, &yRes)
          != noErr        ||
                                          TPutPtrTag(listH, BITS_PER_SAMPLE_TAG, SHORT,
1L,&bitsPerPixel)         != noErr        ||
                                          TPutPtrTag(listH, COMPRESSION_TAG, SHORT,
                                                                                                      1L,
&compressType)            != noErr        ||
                                          TPutPtrTag(listH, FILL_ORDER_TAG, SHORT,
                                                                                                      1L,
&fillOrder)               != noErr        ||
                                          TPutPtrTag(listH, ORIENTATION_TAG, SHORT,
                                                                                                      1L,
&orientation)             != noErr        ||
                                          TPutPtrTag(listH, PHOTOMETRIC_INTERP_TAG, SHORT,
                                                                                                      1L,
&photoInterp)             != noErr        ) {
                          ErrorMessage(BADPUTTAGS);
                          return;
          }

          /* leave room for header in output file */
          SetEOF(refNum, (Int32)sizeof(TiffHeader));
          nextFileFree = sizeof(TiffHeader);

          /* Write out image to file, fixing from Macintosh rounding of rows to the
           * nearest 2 bytes, to the TIFF rounding of rows to the nearest byte.
           */
          if (oddRowBytes)
                          TUnfixOddRowBytes(myBitMapPtr);              /* round rows to nearest byte */
```

```
          startLine = 0;
          bufferPtr = myBitMapPtr->baseAddr;
          while  (startLine < imageLength) {
                    numLines = MIN(imageLength - startLine, rowsPerStrip);
                    if (TWriteImageStrip(refNum, &nextFileFree, listH,
                                                                              startLine, numLines, bufferPtr, plane) !=
noErr) {
                              ErrorMessage(BADWRITEIMAGE);
                              return;
                    }
                    startLine += numLines;
                    bufferPtr += numLines * tiffRowBytes;
          }

          if (oddRowBytes)
                    TFixOddRowBytes(myBitMapPtr);                /* round rows to nearest word */

          /* directory must be on word boundary */
          if (nextFileFree % 2 != 0) {
                    /* add filler byte */
                    count = 1;
                    if (FSWrite(refNum, &count, &dummy) != noErr) {
                              ErrorMessage(BADWRITE);
                              return;
                    }
                    nextFileFree++;
          }

          dirOffset = nextFileFree;

          if (TWriteTags(refNum, byteOrder, &nextFileFree, listH, 0L) != noErr) {
                    ErrorMessage(BADWRITETAGS);
                    return;
          }
          if (TWriteHeader(refNum, dirOffset, byteOrder) != noErr) {
                    ErrorMessage(BADWRITEHEADER);
          }
}

/* Free the list handle and any memory allocated to image description structure.
 */
static void CleanUp(listHandle, idPtr)
Handle listHandle;
id *idPtr;
{
          MyDisposPtr(&idPtr->bitsPerSample);
          MyDisposPtr(&idPtr->compression);
          MyDisposPtr(&idPtr->docName);
          MyDisposPtr(&idPtr->imageDescription);
          MyDisposPtr(&idPtr->make);
          MyDisposPtr(&idPtr->model);
          MyDisposPtr(&idPtr->stripOffsets);
          MyDisposPtr(&idPtr->stripByteCounts);
          MyDisposPtr(&idPtr->minSampleValue);
          MyDisposPtr(&idPtr->maxSampleValue);
          MyDisposPtr(&idPtr->pageName);
          MyDisposPtr(&idPtr->freeOffsets);
          MyDisposPtr(&idPtr->freeByteCounts);
          MyDisposPtr(&idPtr->grayResponseCurve);
          MyDisposPtr(&idPtr->colorResponseCurves);
          DisposHandle(listHandle);
}

void InitID(idPtr)
id *idPtr;
{
          idPtr->subfileType = -1;
          idPtr->imageWidth = 0;
          idPtr->imageLength = 0;
          idPtr->bitsPerSample = nil;
          idPtr->compression = nil;
          idPtr->photoInterp = -1;
          idPtr->threshholding = -1;
          idPtr->cellWidth = -1;
          idPtr->cellLength = -1;
          idPtr->fillOrder = 0;
          idPtr->docName = nil;
          idPtr->imageDescription = nil;
          idPtr->make = nil;
          idPtr->model = nil;
          idPtr->stripOffsets = nil;
          idPtr->orientation = -1;
          idPtr->samplesPerPixel = 0;
          idPtr->rowsPerStrip = 0;
          idPtr->stripsPerImage = 0;
          idPtr->stripByteCounts = nil;
          idPtr->minSampleValue = nil;
          idPtr->maxSampleValue = nil;
          idPtr->xResolution.numerator = 0;
          idPtr->xResolution.denominator = 0;
          idPtr->yResolution.numerator = 0;
          idPtr->yResolution.denominator = 0;
          idPtr->planarConfig = -1;
          idPtr->pageName = nil;
```

(continued on next page)

Listing One *(Listing continued, text begins on page 26.)*

```
		idPtr->xPosition.numerator = 0;
		idPtr->xPosition.denominator = 0;
		idPtr->yPosition.numerator = 0;
		idPtr->yPosition.denominator = 0;
		idPtr->freeOffsets = nil;
		idPtr->freeByteCounts = nil;
		idPtr->grayResponseUnit = -1;
		idPtr->grayResponseCurve = nil;
		idPtr->group3Options = 0;
		idPtr->group4Options = 0;
		idPtr->resolutionUnit = -1;
		idPtr->pageNumber[0] = 0;
		idPtr->pageNumber[1] = 0;
		idPtr->colorResponseUnit = -1;
		idPtr->colorResponseCurves = nil;
}

TiffDirEntry GetDirEntry(listHandle, tagOffset)
Handle		listHandle;
Int32		tagOffset;
{
		Ptr						p;

		/* get pointer to tag list */
		p = &(**listHandle);		/* HANDLE DEREFERENCE */
		/* get pointer to our tag's directory entry */
		p += tagOffset;
		/* return the whole Directory Entry Structure, not a pointer to it */
		return(*((TiffDirEntry *)p));
}


Int16 TypeSize(type)
Int16 type;
{
		switch (type) {
			case BYTE:
				return(BYTESIZE);
			case ASCII:
				return(ASCIISIZE);
			case SHORT:
				return(SHORTSIZE);
			case LONG:
				return(LONGSIZE);
			case RATSIZE:
				return(RATSIZE);
		}
}

Ptr SetIDPtr(listHandle, tag, defaultValue, defaultType)
Handle listHandle;
Int16 tag;
Int32 defaultValue;			/* won't handle defaults larger than 4 bytes */
Int32 defaultType;
{
		TiffDirEntry	tagDE;
		Ptr						p;
		Int32				tagOffset,
								size,
								nvals;

		if (TFindTag(listHandle, &tagOffset, tag)) {
			tagDE = GetDirEntry(listHandle, tagOffset);
			size = TypeSize(tagDE.type) * tagDE.length;
			if ((p = MyNewPtr(size)) != nil)
				TGetTag(listHandle, tagOffset, p, size);
		}
		else if (defaultType != 0) {
			if ((p = MyNewPtr(defaultType)) != nil) {
				switch (defaultType) {
					case BYTE:
						*(unsigned char *)p = defaultValue;
						break;
					case ASCII:
						*(unsigned char *)p = defaultValue;
						break;
					case SHORT:
						*(unsigned short *)p = defaultValue;
						break;
					case LONG:
						*(unsigned long *)p = defaultValue;
						break;
					case RATIONAL:
						((Rational *)p)->numerator = defaultValue;
						((Rational *)p)->denominator = 1;
						break;
				}

				}
			}
			else
				p = nil;
			return(p);
	}
```

End Listings

Listing One *(Text begins on page 46.)*

```
Listing One

/* Virtual Array Header File */
#include <alloc.h>
#include <stdio.h>

/* Virtual Array Control Block typedef */

typedef struct {

   FILE *file;            /* pointer to file control block */
   long size;             /* number of array elements in file */
   int  elsize;           /* number of bytes in each element */
   char *buffer;          /* pointer to array buffer */
   int  buf_elsize;       /* size of element in buffer including index */
   int  buf_size;         /* number of elements in buffer */
   char *blank_rec;       /* pointer to initialization record */
                          /* used for extending file */
} VACB ;                  /* virtual array control block type name */

/* Virtual Array Access Prototypes */

int init_v_array(char *filename,int rec_size,char filchar);
VACB *open_v_array(char *filename,int buffer_size);
void close_v_array(VACB *v_array);
void *access_v_rec(VACB *v_array,long index);
```

End Listing One

Listing Two

```
Listing Two

/*  Virtual Array Access Routines  */

#include <varray.h>

#define header 7

/****************
 * init_v_array *
 ****************/

int init_v_array(filename,rec_size,filchar)
char *filename, filchar;
int  rec_size;
{
   long size;
   FILE *f;
   f = fopen(filename,"wb");
   if (f != NULL) {
      size = 0;
      fwrite(&size,4,1,f);          /* write array size of zero */
      fwrite(&rec_size,2,1,f);      /* and array element size   */
      fwrite(&filchar,1,1,f);       /* and fill char            */
      fclose(f);                    /* to file header */
      return(1);
   }
   else
      return(NULL);
}

/****************
 * open_v_array *
 ****************/

VACB *open_v_array(filename,buffer_size)
char *filename;
int  buffer_size;
{
   VACB *v_array;
   char *buf_ptr;
   int  i;
   char filchar;

   /* allocate virtual array control block */

   v_array = (VACB *) malloc(sizeof(VACB));
   if (v_array == NULL) return(NULL);

   /* open virtual array file */

   v_array->file = fopen(filename,"r+b");
   if (v_array->file == NULL) {
      free(v_array);
      return(NULL);
   };

   /* get array size and element size for control block */

   fread(&v_array->size,4,1,v_array->file);
   fread(&v_array->elsize,2,1,v_array->file);
   fread(&filchar,1,1,v_array->file);
   v_array->buf_elsize = v_array->elsize + 4;
```

(continued on page 65)

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366S

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Listing Two *(Listing continued, text begins on page 46.)*

```
      /* allocate buffer */

      v_array->buffer = (char *) malloc(v_array->buf_elsize * (buffer_size + 1));
      if (v_array->buffer == NULL) {
         fclose(v_array->file);
         free(v_array);
         return(NULL);
      };
      v_array->buf_size = buffer_size;

      /* set up blank_rec using the fill character in array header */
      /* for initializing new array elements */

      buf_ptr = v_array->buffer + v_array->buf_elsize * v_array->buf_size;
      v_array->blank_rec = buf_ptr + 4;
      for (i=0; i < v_array->buf_elsize; i++)
         *buf_ptr++ = filchar;

      /* set record index negative for all buffer elements   */

      buf_ptr = v_array->buffer;
      for (i = 0; i < v_array->buf_size; i++) {
         *((long *)buf_ptr) = -1L;
         buf_ptr += v_array->buf_elsize;
      };
      return(v_array);
   }
      /*****************
       * close_v_array *
       *****************/

      void close_v_array(v_array)
      VACB *v_array;
      {
         int  i;
         char *buf_ptr;
         long rec_index, file_offset;

         buf_ptr = v_array->buffer;

         /*  flush buffer */

         for (i=0; i < v_array->buf_size; i++) {

            /* check each element index */
            /* if element present, write it to disk */

            rec_index = *((long *)buf_ptr);
            if (rec_index >= 0) {
                 file_offset = header + rec_index * v_array->elsize;
                 fseek(v_array->file,file_offset,0);
                 fwrite(buf_ptr + 4, v_array->elsize,1, v_array->file);
            };
            buf_ptr += v_array->buf_elsize;
         };
         free(v_array->buffer);       /* de-allocate buffer */
         fclose(v_array->file);       /* close array file   */
         free(v_array);               /* de-allocate VACB   */
      }

      /****************
       * access_v_rec *
       ****************/

      void *access_v_rec(v_array,index)
      VACB *v_array;
      long index;
      {
         char *buf_ptr;
         int  buf_index;
         long rec_index, temp_index;

         /* calculate buffer address of referenced element */

         buf_index = index % v_array->buf_size;
         buf_ptr = v_array->buffer + buf_index * v_array->buf_elsize;
         rec_index = *(long *)buf_ptr;

         /* if element present, return its buffer address */

         if (rec_index == index) return(buf_ptr + 4);

         /* if element doesn't exist, extend the file */

         if (index >= v_array->size) {
            fseek(v_array->file,0,2);
            for (temp_index = v_array->size; temp_index++ <= index; )
                 fwrite(v_array->blank_rec, v_array->elsize, 1, v_array->file);
            v_array->size = index + 1;
            fseek(v_array->file,0,0);
            fwrite(&v_array->size, 4, 1, v_array->file);
         };
```

(continued on next page)

Listing Two *(Listing continued, text begins on page 46.)*

```
     /* if buffer slot is occupied by another element, */
     /* save it to disk */

     if (rec_index >= 0) {
        fseek(v_array->file, rec_index * v_array->elsize + header, 0);
        fwrite(buf_ptr + 4, v_array->elsize, 1, v_array->file);
     };

     /* read referenced element into buffer slot */

     fseek(v_array->file, index * v_array->elsize + header, 0);
     fread(buf_ptr + 4, v_array->elsize, 1, v_array->file);
     *((long *)buf_ptr) = index;

     /* return address of element in buffer */

     return(buf_ptr + 4);
  }
```

```
Listing Three

/* Example Program Using Virtual Arrays */

#include <varray.h>

/* Access Macros */

#define VREC(i) ((items *)access_v_rec(item_array,i))
#define item(i) VREC(i)->v_item
#define qty(i) VREC(i)->v_qty
#define desc(i) VREC(i)->v_desc

/* Array element structure typedef */

typedef struct {
   int v_item,
       v_qty;
   char v_desc[24];
} items;

main()
{
   VACB *item_array;
   long i;

   /* create a virtual array setting element size to */
   /* the size of items structure and setting the    */
   /* initialization char to the space char          */

   init_v_array("ITEMS.VAR",sizeof(items),' ');

   /* open the virtual array, reserve buffer space for 10 elements */

   item_array = open_v_array("ITEMS.VAR",10);


   /* create 50 array items */

   for (i = 0; i < 50 ; i++) {
      item(i) = i + 1;
      qty(i)  = 0;
      sprintf(desc(i)," Item # %ld", i + 1);
   }

   /* print contents of the 50 array items */
   /* plus the ascii code of last char in v_desc */

   for (i = 0; i < 50; i++)
      printf("Element # %ld  Item = %d  Qty = %d Desc = %s  %d\n",
             i, item(i), qty(i), desc(i), (int) desc(i)[23]);

   /* close virtual array */

   close_v_array(item_array);
}
```

End Listings

Listing One *(Text begins on page 72.)*

```
#include <ctype.h>

char *factor( str )
char    *str;
{
    char *expr();

    if( isalpha( *str ) )         /* F -> name  */
        printf( "%c\n", *str );
    else if( *str == '(' )        /* F -> ( E ) */
        str = expr( ++str );
    return ++str;
}

char *term( str )
char    *str;
{
    str = factor( str );          /* T -> FT'  */
    while( *str == '*' )          /* T'-> *FT' */
    {
        str++;
        str = factor( str );
        printf( "*\n" );
    }
    return str;                   /* T'-> eps */
}

char   *expr( str )
char   *str;
{
    str = term( str );            /* E -> TE'  */
    while( *str == '+' )          /* E'-> +TE' */
    {
        str++;
        str = term( str );
        printf( "+\n" );
    }
    return str;                   /* E'-> eps */
}

main()
{
    char  buf[80];
    while( gets(buf) )
        expr( buf );
}
```

End Listing One

Listing Two

```
typedef struct node
{
    char        name[16];
    int         op;
    struct node *left;
    struct node *right;
}
NODE;

NODE *new()
{
    NODE *p;
    void *calloc();

    if( !(p = (NODE *) calloc( 1, sizeof(NODE) ) ) )
        exit(1);

    return p;
}
```

End Listing Two

Listing Three

```
NODE    *build()
{
    char   buf[80];
    NODE   *stack[ 10 ];
    NODE   **sp = stack - 1;
    NODE   *p;

    while( gets(buf) )
    {
        switch( *buf )
        {
        default:  p = new();
                  strcpy( p->name, buf );
                  *++sp = p;
                  break;

        case '*':
        case '+':
                  p         = new();
                  p->right  = *sp-- ;
                  p->left   = *sp-- ;
```

(continued on next page)

Listing Three

(Listing continued, text begins on page 72.)

```
                        p->op       = *buf  ;
                        p->name[0]  = *buf  ;
                        *++sp       = p     ;
                        break;
                }
            }
            return *sp--:
        }
```

End Listing Three

Listing Four

```
trav( root )
struct node *root;
{
    static int tnum = 0;

    if( !root )
        return;

    if( !root->op )     /* leaf */
    {
        printf ( "t%d = %s\n", tnum, root->name );
        sprintf( root->name , "t%d", tnum );
        ++tnum;
    }
    else
    {
        trav( root->left  );

        if( root->left != root->right )     /* Always true      */
            trav( root->right );            /* unless optimized */

        printf("%s %c= %s\n", root->right->name,
                            root->op, root->left->name );
        strcpy( root->name,   root->right->name );
    }
}
```

End Listing Four

Listing Five

```
optimize( root )
NODE    *root;
{
    /* Stupid optimizer to eliminate common subexpressions */

    char sig1[ 32 ];
    char sig2[ 32 ];

    if( root->right && root->left )
    {
        optimize( root->right );
        optimize( root->left  );

        *sig1 = *sig2 = '\0';
        makesig( root->right, sig1 );
        makesig( root->left , sig2 );

        if( strcmp( sig1, sig2 ) == 0 )    /* subtrees match */
            root->right = root->left ;
    }
}

makesig( root, str )
NODE    *root;

    char    *str;
    {
        if( !root )
            return;

        strcat( str, root->name );
        makesig( root->left,  str );
        makesig( root->right, str );
    }
```

End Listings

Listing One *(Text begins on page 92.)*

```
Listing One

/* MKTABLE.C: Makes a data table with header record */

#include <stdio.h>
#include <string.h>
#define  SIG  19364              /* application file signature */

typedef struct {
  char      fname [20];
  int       ftype, flen;
} DESCR;

struct {                                /* header record for file */
  unsigned  signature;
  int       nrecs;
  char      tablename [10];
  int       reclen;
  long      datastart;
  int       descrsize;
  int       ndescr;
} header;

struct {                                  /* data record for file */
  char      name [20];
  int       age;
} data;

main ()
{
FILE  *fp;
char  age [3];
int    n;
DESCR descr;

  fp = fopen ("database.xyz", "w");              /* create file */

  header.signature = SIG;                   /* initialize header */
  header.nrecs = 0;
  strcpy (header.tablename, "Age list");
  header.reclen = sizeof data;
  header.datastart = 256L;
  header.descrsize = sizeof (descr);
  header.ndescr = 2;
  fwrite (&header, sizeof header, 1, fp);    /* write to file */

  strcpy (descr.fname, "NAME");         /* initialize descriptor */
  descr.ftype = 1;
  descr.flen  = 20;
  fwrite (&descr, sizeof (descr), 1, fp);    /* write to file */

  strcpy (descr.fname, "AGE");                    /* ditto above */
  descr.ftype = 0;
  descr.flen  = 2;
  fwrite (&descr, sizeof (descr), 1, fp);

  fseek (fp, 256L, SEEK_SET);

  do {                                           /* capture data */
    printf ("\nName? ");
    gets (data.name);
    if (strlen (data.name)) {            /* continue until blank */
      printf ("Age?  ");
      gets (age);
      data.age = atoi (age);
      fwrite (&data, sizeof data, 1, fp);        /* write record */
      header.nrecs += 1;                         /* count record */
    }
  } while (strlen (data.name));          /* until no more entered */

  fseek (fp, 0L, SEEK_SET);                /* go to start of file */
  fwrite (&header, sizeof header, 1, fp);    /* update header */
  fclose (fp);                                     /* close file */
}
```

End Listing One

Listing Two

```
Listing Two

PROGRAM nonpas;

  { Reads a non-Pascal database table with a header record }
  { and some number of fixed-length data records           }

CONST signature = 19364;                  { application signature }
      divider = '--------------------------------------------';
```

(continued on next page)

Listing Two

(Listing continued, text begins on page 92.)


```
TYPE  s20              = STRING [20];
      pac              = PACKED ARRAY [1..20] OF CHAR;

  headrec = RECORD CASE tag : INTEGER OF
  1: (signature   : WORD;                        { This is the real layout }
      nrecs       : WORD;                              { # data records }
      placeholdr  : PACKED ARRAY [1..10] OF CHAR;      { table name }
      reclen      : INTEGER;                       { data record length }
      datastart   : LONGINT;                     { file offset for data }
      descrsize   : INTEGER;                   { field descriptor size }
      ndescr      : INTEGER);               { number of fields per rec }
  2: (dummy1,
      dummy2      : WORD;
      tablename   : pac);                         { To fool typechecking }
  3: (stream      : PACKED ARRAY [1..24] OF BYTE);
  END;

  fieldrec = RECORD CASE tag : INTEGER OF
  1: (fname       : pac;
      ftype       : INTEGER;
      flen        : INTEGER);
  2: (stream      : PACKED ARRAY [1..24] OF BYTE);
  END;

VAR   header    : headrec;
      field     : ARRAY [1..10] OF fieldrec;         { descriptors }
      n         : INTEGER;
      table     : FILE OF BYTE;
{ -------------------------- }

FUNCTION asciiz (max : INTEGER; VAR strng : pac) : s20;

    { Returns a Pascal string from a null-terminated string
      that is <= max bytes long }

VAR   i      : INTEGER;
      result : STRING [20];

BEGIN
  result := '';
  FOR i := 1 TO max DO
    IF strng [i] <> CHR (0) THEN
    result := result + strng [i];
  asciiz := result;
END;
{ -------------------------- }

PROCEDURE getDescriptors;

    { Reads field descriptors from header record }

VAR   c, d : INTEGER;

BEGIN
  FOR d := 1 to header.ndescr DO
    FOR c := 1 TO header.descrsize DO
      READ (table, field [d].stream [c]);
END;
{ -------------------------- }

PROCEDURE showHeaderInfo;

    { List information about the file format }

VAR   d : INTEGER;

BEGIN
  WRITELN (divider);
  WRITELN ('Table name is ',
           asciiz (10, header.tablename));
  WRITELN ('Table contains ', header.nrecs, ' records');
  WRITELN ('Data record length in bytes is ',
           header.reclen);
  WRITELN ('Each record contains ', header.ndescr, ' fields:');
  getDescriptors;
  FOR d := 1 TO header.ndescr DO BEGIN
    WRITELN ('   Field name:      ', asciiz (20, field [d].fname));
    WRITE   ('   Data type:       ');
    CASE field [d].ftype OF
      0: WRITELN ('Integer');
      1: WRITELN ('Character');

        END;
        WRITELN ('   Length:         ', field [d].flen);
        WRITELN;
```

```
    END;
    WRITELN ('Data records follow:');
    WRITELN;
  END;
  { -------------------------- }

  PROCEDURE showData;

        { List contents of each data record by fieldname }

  TYPE  int = RECORD CASE tag : INTEGER OF
          1: (number : INTEGER);
          2: (stream : PACKED ARRAY [1..2] OF BYTE);
        END;

  TYPE  charfield = RECORD CASE tag : INTEGER OF
          1: (bf : PACKED ARRAY [1..20] OF BYTE);
          2: (cf : pac);
        END;

  VAR   rec, descr, n : INTEGER;
        intfield      : int;                      { integer data field }
        chfield       : charfield;              { character data field }

  BEGIN
    FOR rec := 1 TO header.nrecs DO                     { For each record }
      FOR descr := 1 TO header.ndescr DO BEGIN        { For each field }
        WRITE (asciiz (20, field [descr].fname));       { Show name }
        FOR n := LENGTH (asciiz (20, field [descr].fname)) TO 25 DO
          WRITE (' ');                               { cosmetic spacing }
        CASE field [descr].ftype OF
          0: BEGIN
           FOR n := 1 TO 2 DO
             READ (table, intfield.stream [n]);       { get int field }
           WRITELN (intfield.number);
          END;
           1: BEGIN
           FOR n := 1 TO field [descr].flen DO
             READ (table, chfield.bf [n]);     { get character field }
           WRITELN (asciiz (20, chfield.cf));
          END;
          END;
        END;
  END;
  { -------------------------- }

  BEGIN
    ASSIGN (table, 'DATABASE.XYZ');                       { open table }
    RESET (table);
    FOR n := 1 TO 24 DO                             { read header record }
      READ (table, header.stream [n]);
    IF signature <> header.signature THEN
      WRITELN ('File not in proper format. Program ended.')
    ELSE
      BEGIN
        showHeaderInfo;                        { Show info about the file }
        SEEK (table, header.datastart);          { go to start of data }
        showData;                              { List each record's data }
      END;
    CLOSE (table);
  END.
```

End Listings

Postfix Notation and Common-Subexpression Elimination

Most compilers don't generate binary executable code; rather, they create a program in an "intermediate language" that is translated into binary by a "compiler back end." This approach has three advantages. First, the same front end can generate code for many target machines by providing several back ends. Second, and conversely, compilers for several different languages can generate the same intermediate code, which can then be used by a single back end. And finally, intermediate code is usually easier to optimize than assembly language is.

It's the third advantage that's the main topic of this month's column: a small compiler along with a simple optimizer that does common-subexpression elimination. The code this month is not all that useful as it stands. For one thing I've left out most of the error checking to make it more understandable. Nonetheless, the concepts are quite useful and apply to several applications apart from compiler design.

One common intermediate language that compilers use is a postfix or reverse-Polish notation. Users of Hewlett-Packard calculators and Unix's dc desk-calculator program will already be familiar with the process. In postfix notation, operands are pushed onto a stack without modification. Operators, however, modify the top few items on the stack. The C fragment A*B+A*B, for example, generates the following postfix operations:

by Allen Holub

push A
push B
pop two items, multiply them, push the result
push A
push B
pop two items, multiply them, push the result
pop two items, add them, push the result

When the input is processed, the result will be on the top of the stack.

A postfix intermediate language is easy to generate because the compiler doesn't have to worry about assigning temporary variables for the rvalues; it just uses the stack as its scratch space. The second advantage is that the optimization pass can reconstruct the entire parse tree—or to be more exact, a compacted form of the parse tree called a syntax tree—from the list of instructions. It turns out that several optimizations are much easier to perform on a syntax tree than on a quad representation of the same program.

Let's look at a concrete example. The earlier expression *(A*B)+(A*B)* can be represented in the following postfix form:

A
B
*
A
B
*
+

There's no need for an explicit *push* operator as long as the operators can be distinguished from variable names. Similarly, explicit parentheses are never necessary because the order of evaluation is determined by the sequence of operations.

The set of subroutines in Listing 1, page 67, form a small recursive-decent compiler that takes as input expressions involving single-character variable names, plus signs, times signs (asterisks), and parentheses. The program outputs the input expression in postfix notation. Multiplication is of higher precedence than addition, and expressions associate left to right. Given the expression *(A*B)+(A*B)*, it produces the output described earlier. The grammar is shown in Table 1, below.

The next step is to recreate the syntax tree from the postfix expression output by the parser (see Figure 1, page 73). Note that all internal nodes represent operators and all the leaves are variable references. Also, the grouping of operators and operands is as you would expect, given the original parenthesized expressions, even though there were no parentheses in the postfix expression itself.

Before demonstrating how to do this reconstruction, I need a data structure to represent the nodes in the tree. Listing 2, page 67, shows this data structure—*NODE*—and a constructor subroutine that makes new nodes—*new( )*. The *NODE* structure is a normal binary-tree node,

expr	<– term expr'	Implemented in expr( )
expr	<– + term expr'	"
	<– ε	"
term	<– factor term'	Implemented in term( )
term'	<– * factor term'	"
	<– ε	"
factor	<– **name**	Implemented in factor( )
	<– (expr)	"

Table 1: *Grammar used by a postfix compiler*

having left and right children. In addition, the *name* field holds variable names (*A* and *B* in this case) or the operator if the node is an internal node. (The contents of this field will be modified by the optimizer, however.) The *op* field holds the operator (* or +) or is set to 0 on leaf nodes.

The *build()* subroutine, shown in Listing 3, page 67, creates a syntax tree from a postfix input file generated by the parser I just discussed. The input file must have one operand or operator per line, and it must be perfect—that is, in order to simplify the code, I've dispensed with error detection. Input lines are read from standard input, and the subroutine returns a pointer to the root node of the tree.

Trees are built in a bottom-up fashion, using a local stack to keep track of the partially constructed tree. The *default* case is executed for variable names. It allocates and initializes a new node and then pushes a pointer to the new node onto the stack. The child pointers are initialized to *NULL* by *new()*.

Operators are handled differently because they're internal nodes. A new node is allocated and initialized, then pointers to two existing nodes are popped and the child pointers of the new internal node are made to point at these. Finally, the new node is pushed.

The tree for the input discussed earlier is built as shown in Figure 2, this page. Code can be generated from this tree by doing a depth-first traversal (visit the children, then the parent). At every lvalue (that is, variable reference), generate a temporary=variable instruction. At every internal node, generate the code necessary to perform the operation on the temporaries that resulted from traversing the previous level, putting the result into a new temporary.

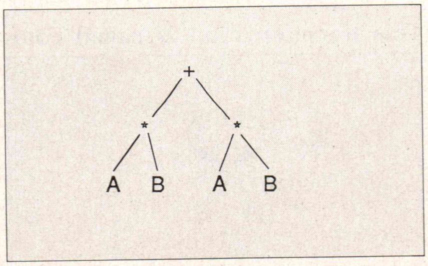

Figure 1: *The syntax tree*

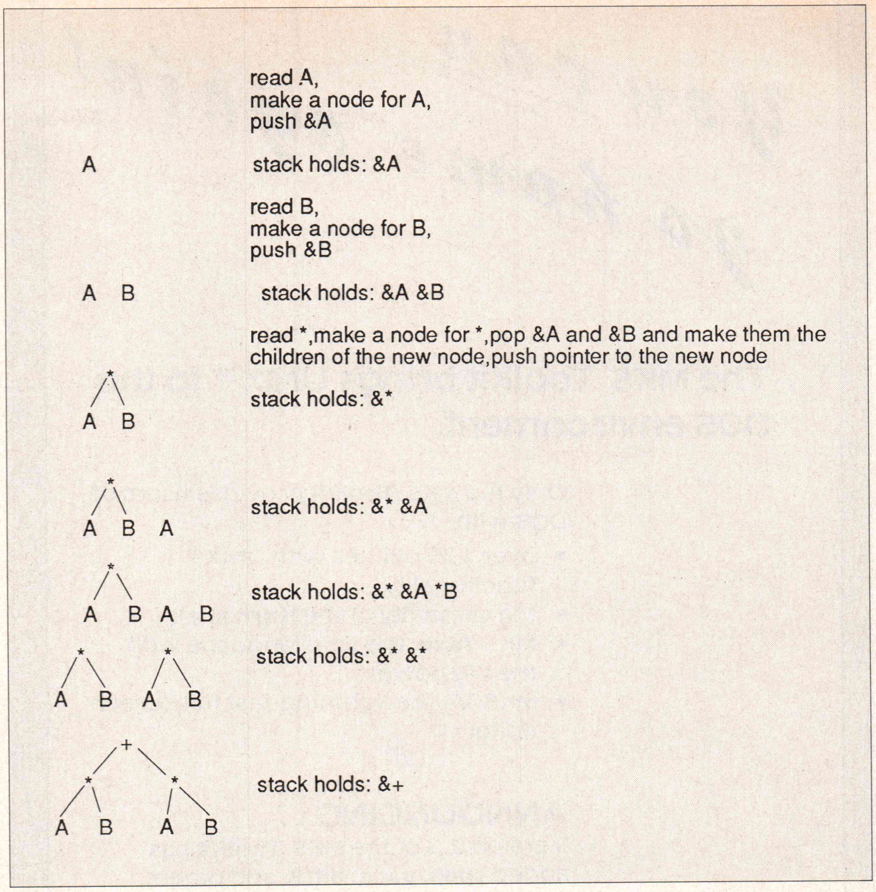

Figure 2: *The input tree*

C CHEST
(continued from page 73)

That is, the previously constructed tree will generate the following output:

```
t0 = A
t1 = B
t1 *= t0
t2 = A
t3 = B
t3 *= t2
t3 += t1
```

The *trav( )* subroutine in Listing 4, page 67, does the traversal. It takes the pointer returned from the previous *build( )* call as its initial argument. If *root->op* is zero, then the current node is a leaf, and you generate the code to move it to a temporary variable. The *sprintf( )* call overwrites the *name* field with the name of the temporary variable. If the *op* field is nonnull, you're processing an interior node. In this case, you do an in-order traversal. The *if* statement is always true (for now—things will change momentarily). The following *printf( )* call prints the instruction, using the *name* fields of the two children to find out what temporaries to use. The *strcpy( )* call then overwrites the *name* field of the current node to reflect the temporary that got the result of the last operation.

The code that *trav( )* outputs isn't too great, primarily because the subexpression *A*B* is evaluated twice. It would be better to perform the multiply only once and use the temporary rvalue generated by that multiply twice. That is, you'd like to generate the following output:

```
t0 = A
t1 = B
t1 *= t0
t1 += t1
```

This transformation is called *com-*

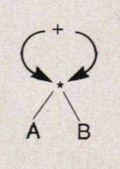

Figure 3: *The new syntax tree*

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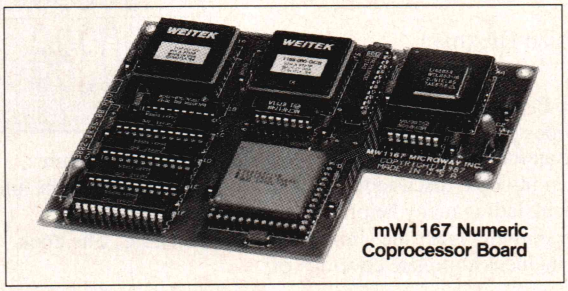

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An example of the benefit of excellent code is a 32-bit matrix multiply. In this benchmark an NDP Fortran-386 program is run against the same program compiled with a 16-bit Fortran. Both programs were run on the same 80386 system. However, the 32-bit code ran 7.5 times faster than the 16-bit code, and 58.5 times faster than the 16-bit code executing on an IBM PC.

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More Rvalues and Implicit Type Conversion

This month's Flotsam and Jetsam continues the subject of rvalues started last month by looking at another problem caused by rvalues and the automatic type-conversion rules. The following code does not work properly:

```
long x;
int y = 32767, z = 32767;
x = y * z;
```

If your machine has a 16-bit *int*, *x* will have the value 1 assigned to it.

The problem here is rvalues—temporary variables that are used by the compiler to hold the intermediate steps of an expression evaluation. The compiler interprets the previous code using the following steps:

1. Copies *y* to the *int*-size temporary *t0*
2. Copies z to the *int*-size temporary *t1*
3. Multiplies *t0* by *t1* and puts the result into the *int*-size temporary *t2*
4. Converts *t2* to *long* and puts the result into the *long*-size temporary *t3*
5. Copies *t3* to *x*

Because the result of the multiplication is stored in an *int*-size temporary, the product will be truncated. That is, 32,767 * 32,767 should yield 0x3fff0001, the top four digits of which will be truncated as part of the assignment.

The problem is that the compiler has no general understanding of the expression as a whole; rather, it knows only about a single operator and the associated operands. It breaks up the foregoing expression into *(x = (y * z))* and then starts evaluating from the inside out—that is, it starts with the multiplication. Because *y* and z are both of type *int*, the result of evaluating the subexpression is put into an *int*-size rvalue. Only after the multiplication is performed will the compiler move out a nesting level and apply the = operator. Now the operands will be *x* and the rvalue that resulted from the previous subexpression. Noticing that *x* is of type *long* and that the temporary is of type *int*, the compiler will correctly convert the *int* to *long* before doing the assignment.

All this is not a bug—the compiler is just doing what you told it to do. You can fix the problem in several ways. The easiest is to declare either *x* or *y* (or both) as *long*. This way the conversion to *long* is moved up to an earlier stage of the evaluation process. Assuming that you've made *y* a *long*, the compiler will do the following:

1. Copy *y* to the *long*-size temporary *t0*
2. Copy z to the *int*-size temporary *t1*
3. Noticing that the two operands are of different types, convert the *int*-size *t1* to the *long*-size temporary *t2*
4. Multiply *t0* by *t2* and put the result into the *long*-size temporary *t3*
5. Copy *t3* to *x*

Alternatively, you could use the cast operator, which creates a temporary variable that has the specified type and then copies the operand to the new variable. You can use any of the following:

```
x = (long)y * z;
x = y * (long)z;
x = (long)y * (long)z;
```

Remember, here, that the cast is an operator. That is, it's executed at run time (unless the optimizer can fix things), and it creates an rvalue of a given type and copies something into that rvalue, doing any necessary type conversions along the way.

You form a cast by writing out a declaration of a variable having the desired type, surrounding the declaration with parentheses, and removing the name and semicolon. For example, to create a cast for a pointer to an array of structures of type *building*, you can use the following procedure:

```
struct building (*p)[10];
(struct building (*p)[10];)
(struct building (*)[10])
```

Note that the parentheses around **p* are required here because *p* is a pointer to an array of structures (as compared to an array of pointers to structures). The parentheses are needed because the brackets are of higher precedence than the start, so the default binding (without parentheses) is *struct building *(p[10]);*.

—*A.H.*

C CHEST
(continued from page 74)

mon-subexpression elimination. The optimization is performed by analyzing and then modifying the syntax tree. Because both subtrees of the + node are identical, the optimizer can eliminate one subtree and make both pointers in the + node point at the remaining subtree. The new syntax tree looks like that in Figure 3, page 74. That is, both pointers in the + node point at the * node. This modified data structure is called a *directed acyclic graph*, or *DAG*.

The DAG is created from the syntax tree by the *optimize()* function in Listing 5, page 68. This routine traverses the interior nodes of the tree, comparing the two subtrees. If the subtrees are identical, the left and right pointers of the parent node are made to point at the same child, effectively removing the other child from the tree. The comparison is done using the *makesig()* function, which traverses an entire subtree, assembling a string that shows the in-order traversal of the subtree by concatenating all the *name* fields. For example, the original syntax tree, when traversed from the root, creates the signature string +***ABAB*. If two subtrees generate the same signature, they're equivalent.

If two subtrees generate the same signature, they're equivalent.

Finally, you can traverse the DAG using the same *trav()* function that you used earlier. That *if* statement will now come into play, however, preventing you from traversing the common subtree twice.

Bibliography

This month's column is an excerpt

C CODE FOR THE PC

source code, of course

Bluestreak Plus Communications (two ports, programmer's interface, terminal emulation)	$400
CQL Query System (SQL retrievals plus windows)	$325
GraphiC 4.1 (high-resolution, DISSPLA-style scientific plots in color & hardcopy)	$325
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MultiDOS Plus (DOS-based multitasking, intertask messaging, semaphores)	$80
WKS Library (C program interface to Lotus 1-2-3 program & files)	$80
ME (programmer's editor with C-like macro language by Magma Software)	$75
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Quincy (interactive C interpreter)	$60
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C Compiler Torture Test (checks a C compiler against K & R)	$20
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WordCruncher (text retrieval & document analysis program)	$275
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Webster's Second Dictionary (234,932 words)	$60
U. S. Cities (names & longitude/latitude of 32,000 U.S. cities and 6,000 state boundary points)	$35
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C CHEST
(continued from page 78)

from a forthcoming book (by myself) on compiler design, to be published by Prentice-Hall in late 1988 (or early 1989).

You can also refer to the following books:

Aho, Sethi, and Ullman. *Compilers: Principles, Techniques, and Tools*. Reading, Mass.: Addison-Wesley, 1986. Pages 25-82 have a discussion about recursive-decent parsing, and pages 279-387 contain more information about advanced optimization techniques using DAGs.

Gries, David. *Compiler Construction for Digital Computers*. New York: Wiley, 1971: 376-411. This book also has a discussion about recursive-descent parsing.

Holub, Allen. *The C Companion*. Englewood Cliffs, N.J.: Prentice-Hall, 1987: 189-212. This book contains an introductory-level discussion of recursion in general and recursive-decent parsers in particular.

Sarff, Gary. "Optimization Strategies." *Computer Language*, vol. 2, no. 12 (December 1985): 27-32. This article has a good discussion of simple peephole-optimization techniques.

DDJ

(Listings begin on page 67.)

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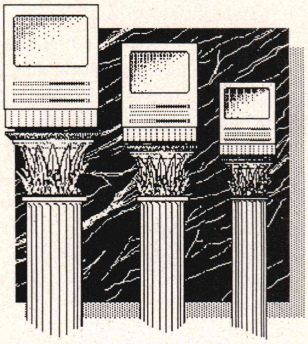
A Macworld Expo Potpourri and the Scouting Toolkit Wrap-Up



I almost didn't go to January's Macworld Expo in San Francisco. I was busy, I was tired, I could read about it later, there was so much to keep learning right here at home, various project deadlines were screaming, late 20th century cities are filled with nuts, it was already too late for one of the really good parties, and on and on—the typical list of yattas. But something inside whispered, "Go." I pay attention to that voice; otherwise it slaps me silly. I went.

Expo in a Nutshell

Quick bottom line: The Mac has won, and this Expo was the happy celebration.

Reasons for victory? Hmm.... How about snap and sizzle? It just feels good to use a Mac. There's some great Mac software. The hardware's gained a lot of horsepower. Thanks go to a lot of people: Xerox PARC, the original Apple Mac team, the early buyers, Apple's tech writers and support teams, all the programmers who've survived the steep learning curve, David E. Smith and his stable of MacTutor writers, Motorola's 680x0 chip design teams, all those who opened the hardware, Jobs, Sculley, and on and on beyond the spatial limits of this column.

The crowd energy at the Expo was a big wave, with as fine a glassy-walled tube to hang a cybernetic ten within as any mass computer event I've attended. There was too much to see, too many people to talk to,

by Stan Krute

and some fun parties with good talk and/or loud, danceable music. All in all, a mighty fine fourth birthday.

Hackus Triumphus

The Mac made one of its first big public appearances at the 1984 West Coast Computer Faire. While talking to an Apple representative at that event, I yammered about memory, hard disks, slotlessness, and printer limitations. He scanned me up and down. Our disguises are easily pierced. "You're a hacker. Those are just hacker issues. Normal users don't need that stuff. We're giving them what they need."

So the Mac took off fast, then almost died. More RAM, SCSI drives, the Mac II, and the LaserWriter, in synergy with some innovative third-party software, brought it back to life and success. One of the treats of the Expo was seeing so many of the people who contributed to that triumph, the once-maligned hackers, now sitting in decision-making positions at Apple and the third-party development companies. Apple's in a particular hacker-hiring frenzy these days, picking up some great Mac people at a torrid pace. Sweet success over time is the best retort to silliness, eh?

Your Code, Your Skills

Looking for places other than Apple to sell all those great Mac programs and programming skills you're busy developing? As I roamed the Expo, I continually asked company representatives if they were looking to buy. I'm not your humble servant for nothing. They were. The consensus: Competent Mac programmers are still a rare commodity. Especially ones who are able/willing to write robust programs that provide specific solutions in very Mac-like ways and don't mind reworking their code in response to intelligent critiques.

So get copies of the Expo guide and/or the leading magazines so you'll have some addresses, crank up the word processor and mail-merge software, and send out those inquiry letters—the window won't be open this wide forever.

Buy This Book

Scott Knaster was at the Expo. He's the Mac tech-support whiz who left Apple for a start-up stint with Guy Kawasaki at Acius. He's now back at Apple, deep into future stuff, and has a new book out: *Macintosh Programming Secrets*, published by Addison-Wesley.

Scott's been immersed in Mac programming for a long time and knows a *lot* about the art and science of it. There may be someone who's examined and debugged more Mac source code from more different programmers than Scott has, but I doubt it. His book pulls together a wide range of important, state-of-the-art, Macintosh programming concepts. It's got grand overviews, detailed techniques, and useful summaries. A lot of stuff you just won't see anywhere else. Plus, Scott explains things well. His writing style's smooth. He throws in history, cartoons, funny jokes, and even a special cameo appearance by Our Nation's Leader.

Sometimes, usually around 3:00 in the morning, I think I know what's going on inside the Mac. The thought has a short half-life. This book gives a more permanent effect and works in the bright light of day. It's one of those products that'll let you enjoy getting smarter. Back in the January column, I gave a short list of books that form the core of a good Mac programming library. Add this one to the group, near the top.

News from APDA

I wanted to talk with Dave Lingwood and Dick Hubert, a couple of

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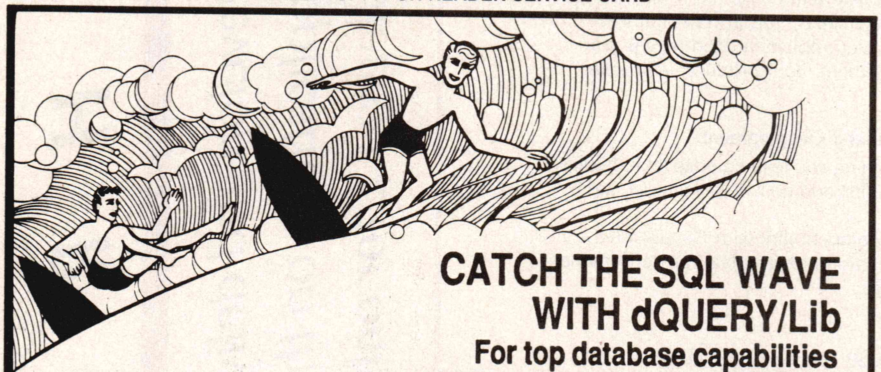

TO THE MACS
(continued from page 82)

longtime Apple communitarians and leaders, respectively, of the Apple Programmer's and Developer's Association and its mother ship, the A.P.P.L.E. Co-op. But they were always in the midst of a continuous feeding frenzy at the APDA booth.

Luckily, I bumped into Frank Catalano, the knowledgeable APDA public relations manager. APDA's up to around 20,000 members. It's got its typical order turnaround time down from 5–7 days to 48 hours. *APDAlog*, the quarterly newsletter/catalog, keeps improving. I've got the January 1988 issue in front of me, and it's fun: good articles that are worth reading and lots of new products to slaver over, including final MPW 2.0.2 tools, a LaserWriter IISC reference, and 14 pages of third-party software tools and books. MPW's pretty remarkable stuff. (Yep, I've bitten the bullet and started to dive in; reports forthcoming, as I always seem to say.)

Of special interest to HyperTalkers: APDA's *HyperCard Technical Reference*, mentioned in the March column, has been enlarged, modified, and split into two pieces. New piece number 1, *HyperCard Script Language Guide*, is Apple's definitive 200-page Hypertalk reference manual. This is a final APDA draft, about 50 percent larger than the earlier (August 11, 1987) draft. New piece number 2, *HyperCard Developer's Toolkit*, contains several goodies. There's a nice typeset document, *HyperCard Stack Design Guidelines*, from Apple's wide-awake Human Interface Group. It lays out the basic principles of intelligent stack design in a coherent way. There's a long MacWrite document that provides the details of writing XCMDs and XFCNs, along with several very useful examples in C and Pascal. There are five sample stacks that illustrate using the included XCMDs to cope with serial-port communications, sounds, and videodisc players. Finally, they've tossed in three sounds: a clang, a flute, and a weird voice saying, "Hi, there." If you're serious about HyperCard development, you'll find both these packages vital.

Finally, if you've got a book or

software tool that'd be of interest to other Mac programmers, send it to APDA for possible inclusion in *APDAlog*. APDA scans carefully, and the good stuff gets in. Not that any of us think of money (heh heh), but you could do a lot worse than to land something in this highly targeted publication.

Tools Keep Evolving, As Do Their Users

Yaaarrrggghh, always running out of time and space. Good ol' Tyler'll have my head. But, before I get down to some code talk: I was able to speak to representatives from Apple, Borland, Think (now of Symantec), Coral, and Smethers Barnes about all their hot new programming tools. Latest versions have hit the streets, as Apple's finished the current batch of major header-file changes. Source-code-level debuggers are coming. Levels of performance and abstraction are rising. The competition's hot. I was impressed by the commitment that these companies are bringing to the programming tools market.

And the programmers! *Ai carambacita!* I wish a few Martian anthropologists could've followed the crew of Macahologists who snaked through the San Francisco streets toward a Szechuan Chinese foodery Saturday night for what's become a main Macworld Expo happening—the Netters' Dinner. Combustible comestibility for a group of cybernauts who usually meet at long electronic distances. Hard to tell which was hotter/faster: the food, its consumption, or the idea flow. What is the link between this kind of cuisine and the programming mind, anyways?

Code Corner

Alright, chitchat's over. Let me calm down by discussing some highlights of the HyperCard Scouting Toolkit (ST) project whose images and code sources were shown in April. Please refer to that column for figures, listings, and an introduction to the project.

A Quick Review

Stacks are composed of one or more cards. Backgrounds hold features that are common to one or more cards. Cards can contain buttons and text fields and graphic designs. Backgrounds can also contain buttons and text fields and graphic designs. Several stacks may be linked by buttons so that they form a set of stacks.

HyperTalk programs consist of a series of message handlers. Things happen when you work with HyperCard, and those events cause messages to be sent to various HyperCard objects: buttons, fields, cards, backgrounds, stacks, external code resources, and the HyperCard program itself. A message passes up a hierarchy leading from simple objects to increasingly powerful ones, until one of those objects deals with the message by handling it and not passing it on. An object's message handlers are contained in its script. Take a look at the various HyperCard books, documentation sets, and help stacks for diagrams of that hierarchy and more detailed descriptions of the flow of control.

If you use the Scouting Toolkit for a while, you'll want to tweak it.

The Stack, the Background, and the Card

The Scouting Toolkit lives on a stack that has one background and one card. The stack has no script. Neither does the background. And the background contains neither fields nor buttons nor graphics. Backgrounds are useful in stacks with more than one card, where they are used to hold information common to several cards. In this simple stack, there's no need for the background to do anything.

The ST card, which I'll call the STBC (Bat Cave), contains 17 buttons and 2 fields. The STBC has a script with two message handlers. Refer to last column's Figure 5 for a picture of the card and last column's Listing One for the script (as well as the scripts of all the other objects in the stack and brief descriptions).

When the card is first opened up, it's sent an *openCard* message. I'm nutty about Zen-like workspaces, so this card's *openCard* handler hides several things: the menu bar, the message box, the tool window, and the pattern window. Later on, buttons on the toolkit let you toggle the visibility of those items. Minor problem in toggling: There are HyperCard functions that tell whether the last three are visible, but no such function exists for the menu bar. So the *openCard* handler stores an indicator in a global variable—one that's known throughout the stack world—imaginatively named *menubarState*.

If someone plays around with the objects on the STBC, certain buttons might go into hiding. A click anywhere in the STBC outside a button will be caught by the card's *mouseUp* message handler. It uses a simple loop to make all the card's buttons show up.

The Buttons

Button 1 is one of the most complex. It's the button that kills the Scouting Toolkit, deleting all its buttons and fields from a card, including itself. Button 1's script handles one kind of message, a *mouseUp*. The button will not delete the ST from the STBC; in that case, it'll flash a warning field at the user. On any other card, though, the message handler removes each button and field via a Victorian clockwork sort of process, as follows.

It turns the cursor into the button tool. For each button it then puts a click at that button's location to select it and calls the HyperCard Edit menu's Clear Button command. Next, it turns the cursor into the field tool. For each field it then puts a click at that field's location and calls on the Edit menu's Clear Field command.

These are two nice HyperCard features: simulating mouse actions and making menu selections. Note how the handler can remove the button whose script it's in. Also, note how I make sure the *userLevel* variable's

(continued from page 85)

high enough to let the handler pull off these tricks and am careful to restore the original *userLevel* when done. (*UserLevel* is a global-state variable that controls access to various levels of HyperCard features.)

Button 14's also interesting. It's the button that replicates the Scouting Toolkit onto a new card. On a mouse click, it copies itself to the Clipboard. Then when you paste it onto a new card, it brings over the entire ST and kills itself. How? Well, once pasted on the replication target, it receives a *newButton* message. The *newButton* handler starts a series of trips, going back to the STBC, copying a button, returning to the target card, and pasting the copied button in. Once all buttons have been transferred, it gets rid of itself, using the technique described earlier.

This process is slow. Using HyperCard's Lockscreen command, so HyperCard doesn't have to draw the screen on each stack round trip, speeds it up somewhat. Still, it'd sure be easier if multiple stacks could be open simultaneously.

Button 3, used to open up the ST, passes a button click on to another button. Button 4 plays music to accompany and emphasize its action. Buttons 5–8 are simple toggle switches. Buttons 9–12 use menu commands. Button 13's analogous to button 2. Button 15 passes a button click on to button 4.

The Fields

There are only two fields. Field 1, normally hidden, shows up and displays a copyright notice under the control of button 15. Field 2, also normally hidden, shows up when someone tries to click button 1 from the STBC. Hidden fields are a neat way to add a sense of animated intelligence to your HyperCard work.

Going Further

If you use the ST for a while, you'll want to tweak it. Two examples that I've worked on are installation into a background and being able to change the spatial configuration of the buttons, with the ST remembering that change. What's interesting is that low levels of object self-manipulation can be done in straight HyperTalk, without resorting to XCMD and XFCN work.

The more I work with HyperTalk/HyperCard, the more I appreciate the convenience, ease, tweakability, and power of the tool. There's a certain simple pleasure to working in its environment, one I haven't had since early BASIC on early micros.

Now, if they can just reduce isolation and modality and get that darned execution speed up. . . .

Reader Mail Snapshots

Thanks to all of you who've proffered feedback—oral, electronic, paper—on my first column (January). I appreciate each piece, pro and/or con. It's a major navigational aid. A few quick gleanings:

Wayne Pollock mentioned the gap in Mac literature between books for novices and those for experts and expressed hope that this column might fill part of that hole. I agree,

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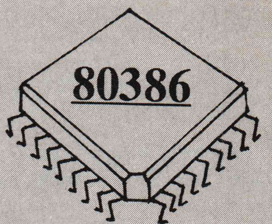

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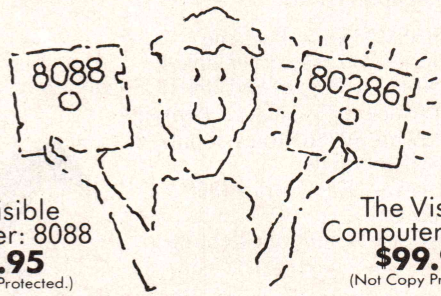

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TO THE MACS
(continued from page 86)

and I'll try. And Scott Knaster's new book, mentioned earlier, should be helpful. Wayne also wants more skeleton code and examples. Good news on that front from Apple itself, where the Developer Technical Support team has started work on a major new code examples effort. And this column will sport a small Multifinder skeleton Real Soon Now, as Prof. Pournelle would say. Wayne also wants some C++ material. Well, as mentioned earlier, I've finally begun fiddling with MPW, partially because I sniff that a Mac C++ will show up in that environment first. When it does, I'll muck about and report back.

James Savidge wrote requesting a little more information about the solitary useless Mac programming tool I mentioned in my first column. It was a C compiler, not one you see advertised anymore, but beyond that I say nothing. I refuse to give a company that won't refund money to a completely dissatisfied customer any form of energy. Besides, I haven't heard or seen squat about the hucksters for years, so hopefully their tent's collapsed and they've sunk back into the dark.

Several programmer buddies were happy to see more Mac coverage here in *DDJ*. I agree. But my favorite piece of mail came from a guy whose name I don't know—the missive's enshrined somewhere down at *DDJ* worldwide headquarters—who was P.O.'d at all the graphics that accompanied the January article. He reads *DDJ* for code, not cartoons. Now *that's* the *DDJ* audience I love! Keep it coming.

Updates and Fixes

Apple's excellent *Human Interface Guidelines* book that I mentioned in the March column is now out in trade form from Addison-Wesley. A lot of the Apple docs will make it out via that route: drafts through APDA, finished stuff via A-W. It's called the *Apple Technical Library*. The folks from Reading do a nice production and finish job.

SuperMac Technology's stopped manufacturing the Enhance board I mentioned in the January column.

Too bad, it was/is a fine product. But we've got the Levco stuff now. Also, the final fix for the parasitic clip problem I mentioned regarding my Enhance board: a piece of carefully connived corrugated cardboard artfully wedged twixt the daughterboard and the clip, applying that constant pressure so needed for reliable electromechanical connection—Kludge Klassic #456.

Minor (Ha! Aren't they all when you own 'em?) bug in the March column's source code: the second instruction in the *doDrawCntl* routine, shown on page 70, should branch to that routine's closing *RTS*, not to the label drawn. So put a label on the *RTS*, say *DoDrCnBye*, and change the line to:

```
BEQ doDrCnBye ; it's invisible, so
no need to draw it
```

This is a branch rarely taken, and the flawed version has a solid chance of not flaming a program. Classic formula for insect survival.

Shut Up and Wrap-Up

Yow, it's time to recede. Thanks to all the nice Maccites at the Expo who took time to share thoughts and endure my nonstandard interviewing techniques, including (but not limited to, as I'm prone to quirky memory and misplaced interview tapes) Harvey Alcabes, Scott Boyd, Frank Catalano, John Draper, Joseph Edozien, Chris Espinoza, Amy Goldsmith, Michael Gosney, Michael Green, Ray Heizer, Glenn Hoffman, David Intersimone, Steve Jasik, Margie Kaptanoglu, Bill Kelly, Scott Kim, Scott Knaster, Richard Koch, David Krathwohl, Lance Lewis, Ken Loomis, Greg Marriot, Julia Menapace, Jeff Nutt, Peter Olson, Howard Pearlmutter, J. Scott Phillips, Heidi Roizen, Gerard Schutten, David E. Smith, Joel Spiegel, Michael Swaine, Wes Thomas, Randall Tinkerman, Neal Trautman, and Steve Splonskowski. With special thanks to Amos Gottlieb and roommates for the fine and classic Haight Street gestalt accommodations.

Next time out? I've given up the prediction racket. My batting average is invisible. But, hey, it'll be fun no matter what, eh? Software! Books! People! Code! Especially code, because I've taken it light this month. So dive happily into those fine mind exercisers y'all are so addicted to, and come back ready to do the logic boogie.

Bibliography

Apple Computer Inc. *HyperCard Developer's Toolkit*, Version 1.0. Available through APDA. Part #KMS036.

Apple Computer Inc. *HyperCard Script Language Guide*. Available through APDA. Part #KMB009.

Knaster, Scott. *Macintosh Programming Secrets*. Reading, Mass.: Addison-Wesley, 1987. ISBN 0-201-06661-0.

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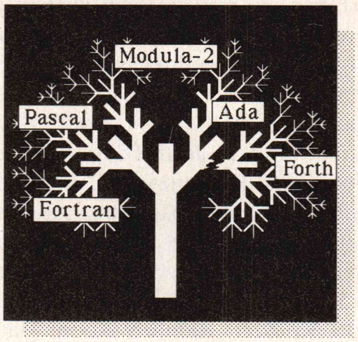

Sometimes a feature of a language is merely a defect put in a favorable light. It all depends on what you're trying to accomplish. Pascal, for example, insists that all files be bound to a data or record type: very noble from the standpoint of preserving the purity of strong typing but often an obstacle when trying to process files formatted in languages other than Pascal.

Specifically, the kinds of files I'm talking about are self-describing tables such as those generated by dBASE, Reflex, and other database programs. Typically, such files begin with several data structures describing the contents, followed by any number of fixed-format data records. It's easy to mix record types with C and assembly language and even BASIC, all of which support free-form files. You have to convince Pascal to do it, though, and the trickery for doing so is the subject of this month's column.

I'll also respond to a reader's complaints about Turbo Pascal 4.0.

Creating a Table File

Rather than covering a specific vendor's table format, I've developed a simple model for this article that is typical of these files in general. What makes it simple is not the file structure itself but instead the number of options. Data records can consist of only two field types: integers and character arrays. The thrust here is the principles, and there's no sense muddying the waters with a num-

by Kent Porter

ber of options that you can figure out for yourself.

The typical table file begins with a fixed-length preamble (256 bytes in this case) containing a header record and field descriptors. The header record is a fixed structure that contains several fields giving basic information about the contents. In this case, the header record is 24 bytes long and contains the fields shown in Table 1, page 95.

Signature is an invariant value written at a fixed place to identify the file as belonging to the application. If some other value appears in that position, the file doesn't follow the rules given here and can't be processed. The value of *signature* for this application is 19364 (4BA4h), and it appears in the first 2 bytes of the file.

The *nrecs* field tells you how many data records the file contains. *Tablename* is a packed array of ten characters giving the name of the table; not all vendors have an analogous field in the header record. *Datastart* expresses an offset, with respect to the start of the file, to the first data record. This is a *long* (32 bits on a PC) integer to correspond with the usage of *fseek/ftell* in C. Turbo Pascal 4.0 and Microsoft Pascal similarly use a *long* integer for their *SEEK* procedures. The last two fields, *descrsize* and *ndescr*, have to do with the next part of the file preamble.

A data record consists of one or more fields, each of which has three attributes: a name, a data type, and a length. These constitute a field descriptor, which has the form shown in Table 2, page 95. Each data field has one descriptor, hence there are *ndescr* field descriptors of *descrsize* following the header record. In the programs that accompany this article, for example, there are two fields (*ndescr*=2), so there are two descriptors.

Thus the preamble consists of a fixed header record followed by a variable number of descriptor records, each of which has a fixed format. Taken together, they describe the data content of the file. The unused portion of the preamble is filled with uninitialized garbage.

The data itself begins at byte offset *header.datastart* from the beginning of the file. Each record corresponds to a row in the data table and each field to a column. The descriptor records describe the columns, and the length of any given record is the sum of all *flen* fields in the descriptors. There are *header.nrecs* records. The file is thus a self-describing entity, and the program's job is to interpret the descriptions in order to extract the data. Figure 1, page 95, shows the format of a simple table.

Listing One, page 69, is a generic C program (MKTABLE.C) that creates a table with the preamble described here. The program then requests data entry and writes out the data records you type in response, saving them in a file called database.xyz. In order to build an adequate table, enter at least three or four records. Terminate data entry by pressing Return when the program asks for a name. The program then updates the header record to reflect the number of data records entered and closes the file. This is a vastly simplified version of a database management package, but it generates a complete table of the same sort that flows out of dBASE and other table-oriented database products.

Translating Strings

The references to *pac* (a packed array of characters) in Figure 1 and Table 1 point up a fundamental difference between Pascal and lower-level languages such as C and assembly language. Although not de-

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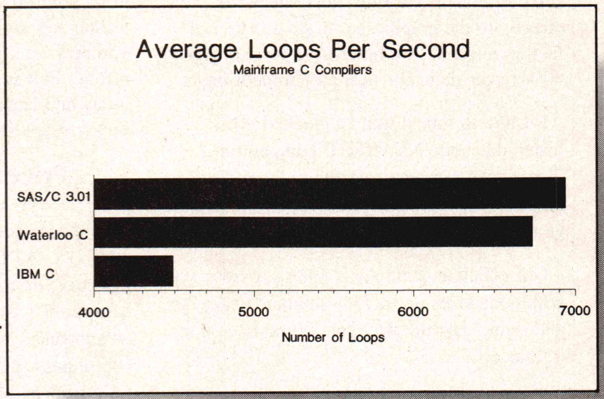

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STRUCTURED PROGRAMMING
(continued from page 92)

fined in the academic standard, the *pac* string type is supported by most real-world Pascal compilers. It's really a stretched *PAC*, the difference being that element 0 contains the string length, with the first valid character at element 1. Thus, at the data level, a string containing the word *Pascal* looks something like *6Pascal*. If the string were declared as:

```
VAR strng : STRING [10];
```

the last 4 bytes would contain garbage. The compiler inserts string-handling routines that pay attention to the length byte.

C handles string data differently, and most assembly-language programmers use the same convention as C. It's so common, in fact, that it has a name: ASCIIZ. In ASCIIZ, the 0th element contains the first character of the string. There is no length indicator; instead, end-of-string is signified by ASCII value 0, or *CHR (0)* in Pascal notation. This is merely a packed array of characters with a special end sentinel. The C term for it is a *null-terminated* string.

The *asciiz* function in Listing Two, page 70, transforms ASCIIZ strings into Pascal strings. Because it's possible that a string might exceed its maximum length, the function also takes the *max* parameter, which limits the number of characters in the result; it's either *max* characters or everything up to the null terminator, whichever comes first.

This string-translation routine and the liberal use of variant records are two keys to convincing Pascal to read non-Pascal tables. The third is processing the file on a byte-by-byte basis. Here's how it works.

Processing the File

The program declares the table as *FILE OF BYTE* and opens it. The first step reads the 24-byte header record into the stream variant of the *headrec* structured variable. This is necessary because the file is of type *BYTE*; all file reads are done in the same way. Access to the data elements is via the other variants, as in the next step, which checks *signa-*

ture. Execution continues if the *signature* is correct and ends with a message otherwise.

Procedure *showHeaderInfo* lists information from the header record. Note that the table name is drawn from the second variant of the *headrec* record. Why? Because the *asciiz* function expects an argument of type *pac*, which is 20 bytes long, whereas the real *tablename* field is only 10 characters long. This is a trick to prevent the compiler from choking on a mismatched type.

The *getDescriptors* procedure, called by *showHeaderInfo*, reads the field descriptors that follow the header file. The program assumes a maximum of ten fields for the table when it declares the *field* variable, which is an array of *fieldrec* structures. The *header.ndescr* variable governs the actual number read from the file. *ShowHeaderInfo* uses the descriptors to display information about the fields. The *showData* procedure uses them more extensively.

Before calling *showData*, however, the program first calls the Pascal *SEEK* procedure. The purpose is to reposition the file pointer to the start of the data records, which is past the unused portion of the preamble. *ShowData* can now read and process the table's data contents sequentially.

A couple of local variant record types provide the means for fetching integers and ASCIIZ strings. Again, the stream component furnishes type compatibility with the file. Because the host processor and not the compiler establishes the format of the integer type, an integer taken from the file as two consecutive bytes can be plucked directly from the variant without translation. The character field is accessible via a call to *asciiz*.

A pair of nested loops control the reading and display of data fields. The outer loop repeats for the number of records in the file, as given by *header.nrec*. The inner loop processes individual fields, stepping through the array of descriptors in order to determine what to read next from the file. Because it's loop-driven, *showData* can process any

Name	Type
signature	word
nrecs	word
tablename	pac [10]
datastart	longint
descrsize	integer
ndescr	integer

Table 1: *Names and types of fields in the header record*

Name	Type
fname	pac [20]
ftype	integer
flen	integer

Table 2: *A data record's field descriptors*

Header	$4BA4	(=signature)
	4	(=nrecs)
	Age list	(=tablename)
	256	(=datastart)
	24	(=descrsize)
	2	(=ndescr)
Descriptor#1	NAME	(=fname)
	1	(=ftype {pac [20]})
	20	(=flen)
Descriptor#2	AGE	(=fname)
	0	(=ftype {integer})
	2	(=flen)
Rest of preamble	(garbage filler)	
Data records (datastart)	Ken Barker, 46	
	Tim Madden, 38	
	John Joyner, 42	
	Jim Hull, 59	

Figure 1: *Format of a simple table*

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(continued from page 95)

number of records consisting of any number of integer and ASCIIZ fields in any order without modification. Additional data types would require the appropriate structure definitions and expansion of the *CASE* statement.

This is not a complete table system, of course, because it lacks date, floating-point, and Boolean types. Also, it's not compatible with any existing database package's file format. Given the specifications for a file and the techniques presented here, however, you should be able to write a Pascal program that reads non-Pascal files with header records.

Turbo Pascal 4.0 Flames

The mail the other day brought a letter from Charles Linett, who heads up the Computer Science Staff at the Census Bureau. Charles and his folks use Turbo Pascal for communications programs of 15,000+ lines, and he's not amused by Version 4.0. Here's part of what he has to say:

"I see two rather large defects bordering on the semicalamitous for our type of work.

1. There are no overlays (as there were in Version 3.0). Borland has solved that problem in two suave ways, however. First, the company told us that if we used overlays, then we needed only to rewrite our programs (thanks, fellas, you're a big help). Second, Borland found the part of the documentation least likely to be read (a file called Q&A) and wrote that it recognized the need and was working on something 'intelligent.' I can only hope it gets it done before those awaiting the feature die of old age.

2. The manual is awful and (worse yet) has almost no chance of improvement. It requires so many additions and corrections that what is called for is a new manual altogether. If 20 pages need changing in a real manual, you send the customer those 20 pages and let him or her stick them in the book. This cannot be done with the 4.0 manual because it's glued together in one big lump."

No quarrel with the first point, Charles; I'll get back to it in a minute. As for the second, probably a lot of us aren't crazy about a bound book as a manual. And that one in particular is too thick; you can't spread it out on the desk for reference without either breaking the spine or putting barbells on it for paperweights. But the adjective *awful* is kinda harsh. Versions 2.0 and 3.0 had bound manuals, too, and Borland isn't the only company whose docs come this way.

Nobody's ever told me this, but I suspect the purpose of bound docs is to discourage pirates from photocopying the manual. Maybe if the world was a more honest place, vendors such as Borland wouldn't resort to defensive tactics. Piracy is just another name for theft.

Yeah, I don't like the manual either, but it's a whole bunch better than its predecessor in terms of both quality and content. And manual corrections conveyed via

STRUCTURED PROGRAMMING

(continued from page 97)

READ.ME files are hardly a Philippe Kahn innovation.

Now for the overlay fiasco. No doubt about it, Borland shot itself in the foot by dropping overlays. Probably it figured it could get away with it because Version 4.0's .EXE files break through the infamous 64K barrier of Version 3.0's .COM files. Somebody should have surveyed the user community before Borland yanked the rug from under it.

But there's an alternative for Charles and anybody else who got abandoned. It's a product called Overlay Manager 4.0 from TurboPower Software (3109 Scotts Valley Dr., Ste. 122, Scotts Valley, CA 95066; 408-438-8608). Costing $45, this is an interactive program that lets you break a compiled .EXE file of any size (up to about 1 Mbyte) into any number of overlays. For truly enormous programs, there's another utility in the package that effects chaining. The slim 30-page manual is excellent and so's the quality of the software; TurboPower produces good stuff. Highly recommended if you need overlays.

Availability

All the source code for articles in this issue is available on a single disk. To order, send $14.95 to *Dr. Dobb's Journal*, 501 Galveston Dr., Redwood City, CA 94063, or call 415-366-3600, ext. 221. Please specify the issue number and format (MS-DOS, Macintosh, Kaypro).

DDJ

(Listings begin on page 69.)

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All Source Code Maximizes Turbo Pascal 4.0

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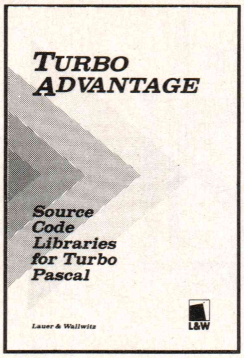
by Lauer & Wallwitz



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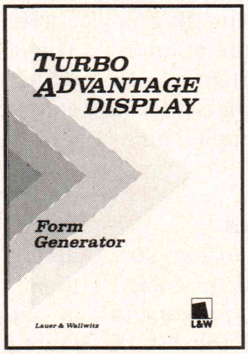

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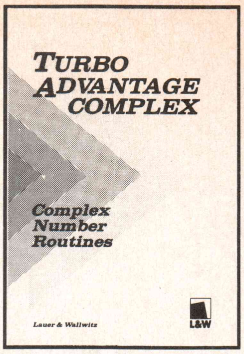

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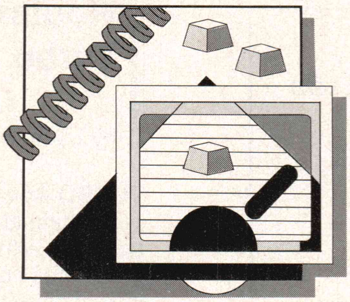
Parallel Processing, Object-Oriented Programming, and a Reading List



Several of the key difficulties of my original text cluster about the concept of a paradigm...One sympathetic reader...prepared a partial analytic index and concluded that the term is used in at least twenty-two different ways.

—*Thomas Kuhn*

Authors who use the word *paradigm* seem to permit themselves to mean by it a large number of different, and perhaps contradictory, things; and as I am committing myself to dealing with paradigms each month, I will honor this wise and liberal tradition.

A column called Programming Paradigms should, though, at least, deal with the issues Robert Floyd brought up in his 1978 Turing Award Lecture, "The Paradigms of Programming" (even though Floyd didn't define paradigm either). Floyd deplored the segmentation of computer science into narrow communities, "each speaking its own language and using its own paradigms...well-defined schools of LISP programming, APL programming, ALGOL programming, and so on." Such communities develop not just around languages but around any broadly applicable problem-solving technique, including such diverse techniques as recursion, stepwise refinement, generate-and-test, and data-flow design.

Programmers advance in their careers by learning a community's shared techniques, terminology, values, prejudices, model problems,

by Michael Swaine

and concrete examples of how to solve such problems—what Thomas Kuhn, who investigated scientific paradigms, calls puzzle solving. This is the process of adopting a paradigm, and it prepares the programmer to answer an ad for a "C programmer" or a "software engineer" or a "knowledge engineer" or a programmer "with experience in object-oriented design."

A column called Programming Paradigms should offer some insight to the atypical programmer for whom this is not enough, the programmer who wants to add to his or her repertoire of paradigms.

This column will attempt to do that by exploring techniques from parallel processing, programming in logic, functional programming, object-oriented programming, and other alternative models. The focus will be on pointing out the alternatives to familiar, conventional methods. I can't think of a better place to begin the exploration than in the wilderness of MIMD parallel processing.

Parallel Paradigms

When I conducted an informal survey through the pages of the magazine last year, parallel processing came out at the top of the list of topics readers would like to see *DDJ* cover more often. It's not surprising; parallel processing promises increased throughput independent of other speedup techniques, and parallel processing raises new problems to be explored—a lot of them—the parallel world is bigger than the sequential world. There are many paradigms of parallelism, some better mapped than others. One of the least explored is MIMD parallelism.

The term *MIMD* means multiple instruction, multiple data. Logically, there are four such terms, representing the application of parallelism to instructions, data, neither, or both. The terms can be applied to both architectures and algorithms. SISD (single instruction, single data) is the familiar sequential Von Neumann model for computer architecture and programming; and MISD, in which multiple instructions are applied to single data items, turns out to be in practice indistinguishable from SISD. That leaves two broad paradigms of parallel processing: single instruction, multiple data (SIMD) and multiple instruction, multiple data (MIMD).

SIMD breaks down into two lower-level paradigms, each with its community of practitioners, traditions, model problems, and typical solutions. These are array processing and vector processing.

The array-processing paradigm (see Figure 1, page 102) involves a sequence of instructions applied concurrently to disjoint sets of data. The ICL Distributed Array Processor, which consists of a control unit and a 64×64 array of processors, each with its own local memory, is one example of this paradigm. In it, the control unit drives the parallel processors, which all perform the same operation in lockstep on the data in their local memory. This paradigm is natural for matrix mathematics, graphics processing, and other uniform operations on arrays of data—hence the name array processing.

The vector-processing paradigm, which is also called pipelining, involves instructions overlapped on disjoint sets of data (see Figure 2, page 103). With pipelining, additional operands can be fed into an operation before it has finished with the first because the operations are broken down into stages and the stages are processed in parallel.

You can see architecture designed for pipelining in supercomputers such as the Cray-1, which are often called vector processors because they process a vector of operands in

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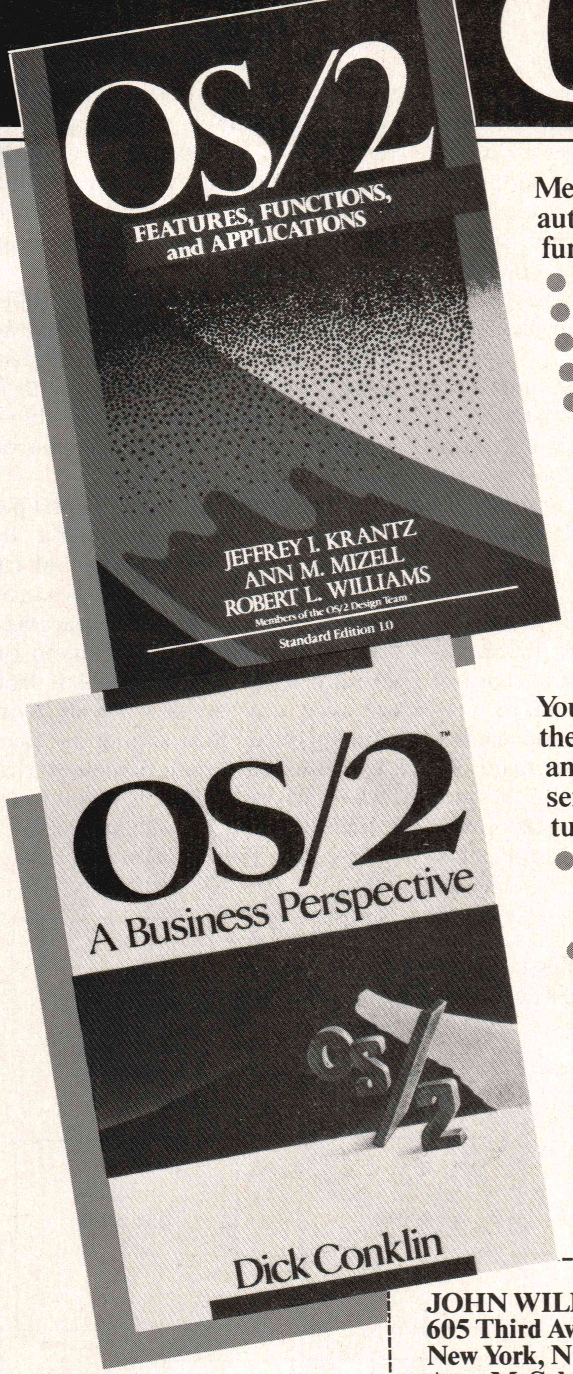

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(continued from page 100)

parallel. You can also see pipeline architecture in the microprocessors of desktop computers. The Motorola 68030, for example, can fetch both instructions and data from on-chip caches, refresh the caches from off-chip memory, and ready the address for an off-chip fetch, all in parallel. Pipelining in CPU architecture and operating system design is a well-established technique. Extending this technique to a computer system as a whole presents a new paradigm, presently seen chiefly in supercomputers.

Both vector processing and array processing are single-instruction, multiple-data parallelism, and consequently they exhibit the traits of SIMD. SIMD approaches typically involve a high degree of parallelism; that is, many array or vector elements are processed at once. They restrict this parallelism to a low level, such as the level of the operation. They exhibit central control and strong synchronization. As a result of these traits, SIMD approaches concentrate most of the need for special algorithms at the system level and present no special problems in communication among the parallel elements.

MIMD Parallelism

In contrast, MIMD approaches usually involve fewer but more powerful processing elements, with a medium degree of parallelism and parallelism at a higher level—the level of the task. Control is distributed, and synchronization is only occasional. As a result, MIMD paradigms raise difficult problems in communication among the parallel tasks as well as higher-level problems in the design of algorithms.

In an MIMD architecture, different parts of an application program are given to different, independent, networked processors, each with its own instruction set, each capable of performing a sequence of instructions without supervision.

At the algorithmic level, MIMD parallelism means decomposing the problem into components that can be attacked in parallel via separate processes. This is a true paradigm shift; you envision the problem differently in MIMD parallelism from the way you envision it in SIMD parallelism or in a sequential paradigm. SIMD is a paradigm shift away from SISD, but MIMD is a shift away from SIMD and it's a bigger shift.

If Henry Ford's assembly line is

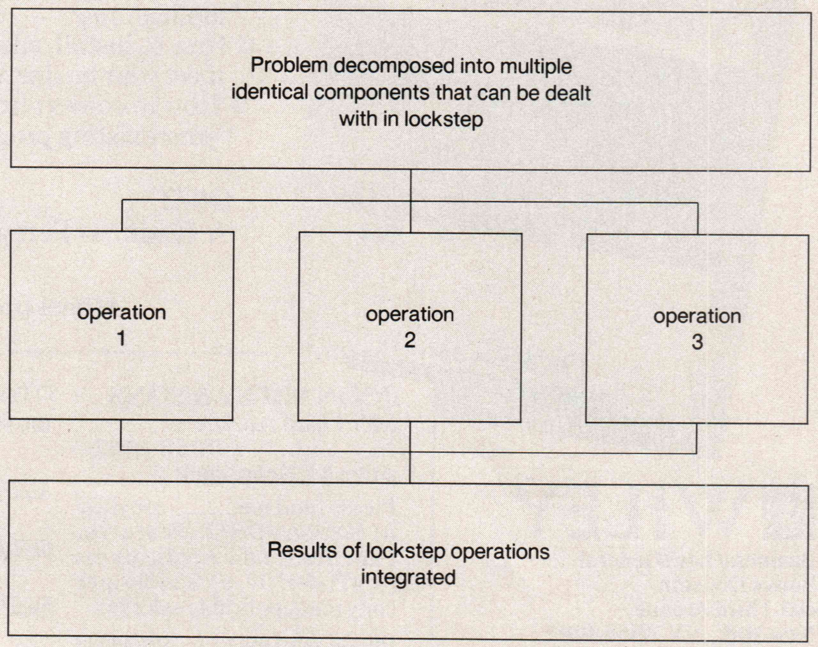

Figure 1: *Array processing applies the same operations to many data sets at the same time, achieving a lockstep parallelism.*

the metaphor for vector processing, then the array-processing metaphor is all those WACs plugging away at elementary arithmetic operations in lockstep back during World War II. MIMD parallelism is closer to the model of research within a scientific community, where, in pursuit of a common goal, individual researchers handle their own tasks, sharing information when it seems mutually beneficial—ARPAnet, including the networkers.

MIMD architectures (see Figure 3, below) are to date mostly experimental. Shared memory and nonshared memory architectures have been tried, as have been various topologies for the linking of the processors. The Denelcor Heterogeneous Array Processor and Cray X-MP are two commercial MIMD machines, and CalTech's Hypercube is a model that has been generating a lot of interest this year. But MIMD architectures are moving onto the desktop, and it is already possible to experiment with MIMD parallelism for the price of a fully loaded personal computer.

Foreseeing this possibility, Les Record, of Round Rock, Texas, sent me the following suggestion:

"Your discussion of problems in parallel computing brought to mind an idea for a major *DDJ* project: using minimal hardware, say 6 to 8 Z80s, interconnected in a simple network, present a series of articles using parallel techniques to solve simple (?!?) problems. If you don't want to present a hardware article (one every 2–3 years doesn't hurt), then perhaps some OEM might contract to build a minimal parallel system. Does this sound feasible? I think the hardware could be low-cost. The pay-

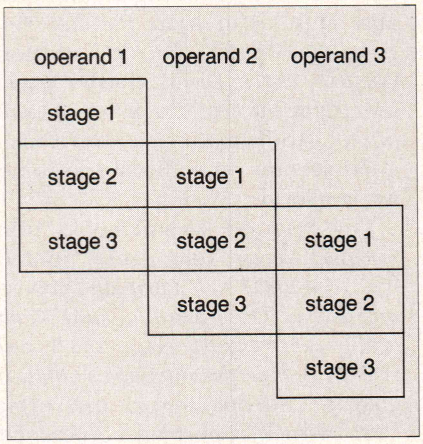

Figure 2: *Vector processing, or pipelining, achieves parallelism by overlapping the components of a multicomponent process, much as automobiles are built in parallel on a Detroit assembly line.*

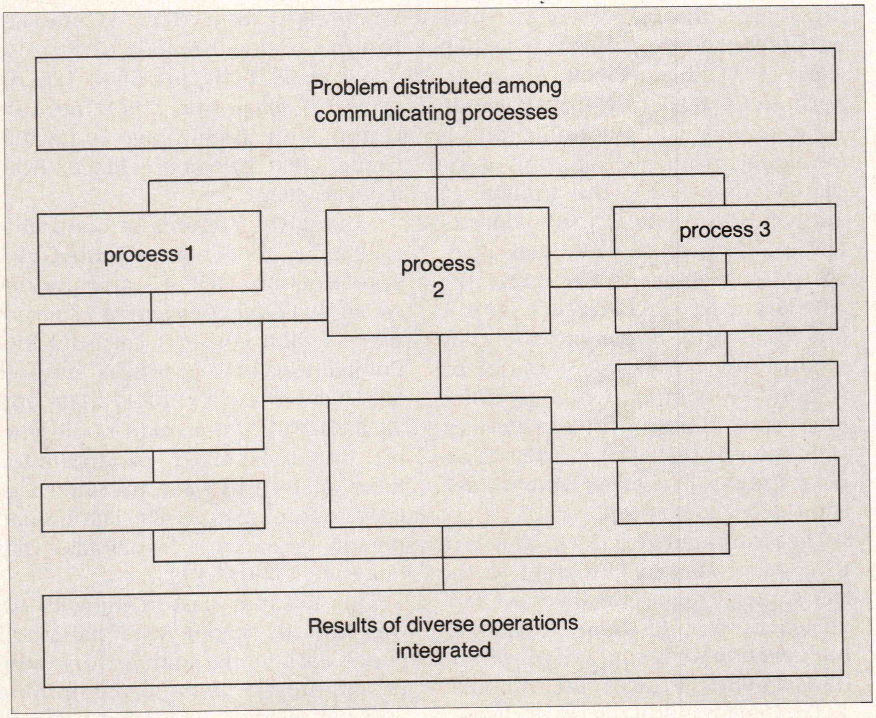

Figure 3: *MIMD (multiple instruction, multiple data) parallelism is typically asynchronous, with independent processes communicating with one another to achieve occasional synchronization.*

Sources

A column such as this can't begin to deal with its subject matter in the depth that, say, a column on C programming for MS-DOS can. I have only touched on many important issues in this installment. So here are some places where you can find the issues treated in greater depth.

You can find a good overview of parallel programming techniques and architectures in *Parallel Programming* by R.H. Perrott (Addison-Wesley, 1987). David Harel's excellent *Algorithmics: The Spirit of Computing* (Addison-Wesley, 1987) has a good section on some of the issues in parallel processing.

I also found several books from Springer-Verlag very useful, including *WOPPLOT 86, Parallel Processing: Logic, Organization, and Technology* (Springer-Verlag, 1987) and *PARLE, Parallel Architectures and Languages Europe* (Springer-Verlag, 1987), which report on conferences held, respectively, in Neubiberg, Federal Republic of Germany, in 1986 and in Eindhoven, the Netherlands in 1987.

The best source of information about the INMOS transputer is INMOS itself, through various technical notes. The U.S. contact is INMOS Corp., P.O. Box 16000, Colorado Springs, CO 80935; 303-630-4000.

Levco has video training and a developer group for learning about parallel processing, the transputer, and Levco's Macintosh boards. Levco is located at 6160 Lusk Blvd., Ste. C-100, San Diego, CA 92121; 619-457-2011. Levco's boards are not the only transputer implementation you might want to investigate; Definicon is another company that is doing interesting things with the devices. Definicon is located at 1100 Business Center Circle, Newbury Park, CA 91320; 805-499-0652.

Dick Pountain and David May give a very readable introduction to the transputer's high-level machine language, occam, in their *A Tutorial Introduction to Occam Programming* (INMOS/BSP Professional Books, 1987). Occam is still nearly undiscovered; this was one of only four books devoted to occam that I was able to find in a search of the entire University of California library system. Perrott's book also gives a clear introduction to Hoare's CSP and to occam as an implementation of CSP's central concepts as well as showing how parallel processing is implemented in a number of other languages, including Ada and Pascal Plus.

For explicit definitions of object-oriented programming, I drew upon "What Is Object-Oriented Programming," an invited lecture by Bjarne Stroustrup reprinted in *ECOOP '87: European Conference on Object-Oriented Programming* (Springer-Verlag, 1987); *Object-Oriented Programming: An Evolutionary Approach* by Brad Cox (Addison-Wesley, 1986); and the August 1981 and August 1986 issues of *Byte*.

But object-oriented programming is better defined by example in such sources as *Smalltalk-80, the Language and its Implementation* by Adele Goldberg and David Robson (Addison-Wesley, 1983); *The C++ Programming Language* by Bjarne Stroustrup (Addison-Wesley, 1986); and the documentation for Digitalk's Smalltalk-V and The Whitewater Group's Actor. Digitalk Inc. is located at 9841 Airport Blvd., Los Angeles, CA 90045; and The Whitewater Group is at Technology Innovation Center, 906 University Place, Evanston, IL 60201.

Among the sources of continuing education for object-oriented programmers are OOPSLA and the new *Journal of Object-Oriented Programming*, which you can get from SIGS Publications, 310 Madison Ave., Ste. 503, New York, NY 10017; 212- 972-7055. OOPSLA, the main conference on object-oriented programming, takes place this year in San Diego, Calif., September 25–29. The contact person is Barbara Noparstak, Digitalk Inc.; 213-645-1083.

This column had nothing to say this month about artificial-intelligence paradigms, such as functional programming, logic programming, and neural nets. The least I can do is to mention some good sources in these areas.

I am looking forward to my first issue of a journal devoted to LISP, called *LISP and Symbolic Computation: An International Journal*, edited by Richard Gabriel and Guy Steele. You can order it from Jan Zubkoff, *LASC*, Lucid Inc., 707 Laurel St., Menlo Park, CA 94025; 415-329-8400. Steele and Gabriel are, among other things, the authors of two important books on LISP—*Common LISP: The Language* by Guy L. Steele, Jr. (Digital Press, 1984) and *Performance and Evaluation of LISP Systems* by Richard P. Gabriel (MIT Press, 1985).

The Prolog language gets its name from the exaggerated notion that you are programming in logic when you use it. A new book removes some of the exaggeration by showing how to use and extend Prolog to do true logic programming; it's *Computing with Logic: Logic Programming with PROLOG* by David Maier and David S. Warren (Benjamin/Cummings, 1988).

A journal on neural network technology is available from *(TK)*. A conference on neural nets will also be held in San Diego, Calif., from July 24-27. It's sponsored by the IEEE and you can get more information from Nomi Feldman at 619-453-6222.

The big conference for the artificial-intelligence community is AAAI, held this year in St. Paul, Minn., from August 22-26. Call 415-328-3123.

Philosopher of science Thomas Kuhn made the term paradigm mean so much in his landmark book *The Structure of Scientific Revolutions* (University of Chicago Press, 1962). The disclaimer quoted at the beginning of this column is from the postscript in the second edition of this book, published in 1970. Robert Floyd's Turing Award lecture appears in *ACM Turing Award Lectures, The First Twenty Years: 1966–1985* (ACM Press, 1987)—a wonderful book. Most of the lectures in it not only deserve reading but also reward rereading. —M.S.

(continued from page 103)

off would be exposure to software—hands-on! I might even be able to help."

I especially like that last sentence. I'm passing Les' suggestion along to Tyler and the gang. But if the goal is exposure to the programming problems of MIMD parallelism rather than the architectural issues, wouldn't it make sense to buy the hardware off the rack? This is now possible with the INMOS transputer.

Transputers

Interest in the transputer is growing. Last summer, the Macintosh SIG of the Software Entrepreneur's Forum polled its members for topics for future meetings, and the hands-down winner was the INMOS transputer.

The transputer is a 32-bit RISC chip designed by INMOS Ltd. for parallel processing. It includes a processor, local memory, and four dedicated I/O ports. Several transputers in a simple network can be used to implement MIMD parallelism. The transputer can switch between parallel tasks in a microsecond.

Transputers can be linked in a network, with a great deal of flexibility in the topology of the network and in the physical location of the nodes: transputers on the same network need not occupy the same circuit board, the same system bus,

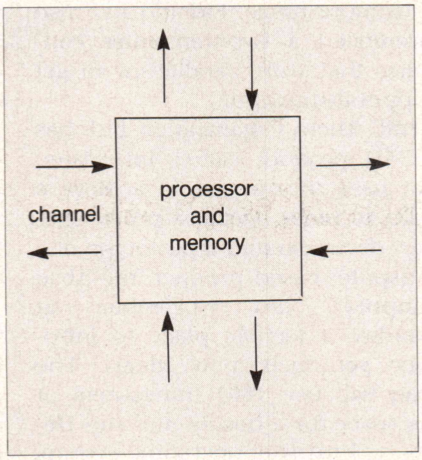

Figure 4: *One transputer processor. Independent processes can run in parallel on individual transputers, communicating with one another via the four channels each transputer has.*

(continued from page 105)

or the same city. Intertransputer links are point to point, so the size of the network is not limited by contention problems as it would be on a common bus. And the number of transputers in the network can be increased or decreased without altering the parallel program running on the network. (See Figure 4, page 105.)

The transputer is already being used in commercial products. Two companies have announced transputer-based boards that will significantly speed up laser printers.

The domain of MIMD algorithms is still wide open.

Both CSS Laboratories and Eidolon will be showing laser printer controller boards this year, each employing one T414 transputer as a coprocessor for throughput in the 8–20 page-per-minute range. Eidolon has also announced a two-transputer controller that uses parallelism to get 40 ppm throughput.

HRC Micro Organization Ltd. has a CAD product called Intervision that uses transputers to achieve a 10 to 40 times speed improvement. Atari demonstrated a prototype of a transputer-based product, the Abaq computer, last November (at Comdex, a terrible place to introduce genuinely new ideas). The Abaq will use T800 transputers (it has space for a dozen) and run Helios, a Unix-like operating system, with an MS-DOS emulation mode that should run DOS programs faster than an AT. Penguin Software is developing Unix-based transputer development tools. And Levco is selling transputer boards for personal computers.

It's Levco's boards I had in mind when I alluded to building a parallel-processing system from off-the-rack parts. Levco allows you to turn a Mac II or SE into a parallel-processing system with a package it calls TransLink. TransLink consists of a bus card, transputer modules, and either MPW-compatible development software (C compiler, transputer assembler, loader, linker) or the occam development system from INMOS. The transputer modules include 256K to 4 Mbytes of RAM in four SIMM sockets and one transputer (T414 15 MHz, T414 20 MHz, or T800 20 MHz with 64-bit IEEE floating-point support). The bus card for the Mac II can hold up to four transputer modules, whereas the SE card can hold only two.

Fully loaded with five TransLink Nubus-compatible boards, holding a total of 20 20-MHz T-800 transputer modules, each with from 256K to 4 Mbyte of its own RAM, a Mac II would reach a throughput of nearly 200 MIPS. (If only I weren't already in debt up to my neck for the Mac II. . . .)

Coming down from the clouds, I should explain that Levco's boards provide an opportunity for developers to explore the largely unknown territory of MIMD algorithms.

MIMD Programming

The domain of MIMD algorithms is still wide open. There are many hard problems to be solved, including questions of appropriate topology, general techniques for functional decomposition, and specific MIMD algorithms for familiar problems. Small-scale functional decomposition, with just a few processes running in parallel, can produce performance unattainable in any other way.

It is only fair to point out, though, that there are those who doubt the benefits of large-scale MIMD parallelism. Their arguments rest on a strict upper bound on those benefits: the limit set by Amdahl's law.

Amdahl's law states that parallel speedup (the ratio of the speed of processing using any parallel technique whatsoever to the speed of the strictly sequential approach) is bounded above by $100/[(100-f)+f/p]$,

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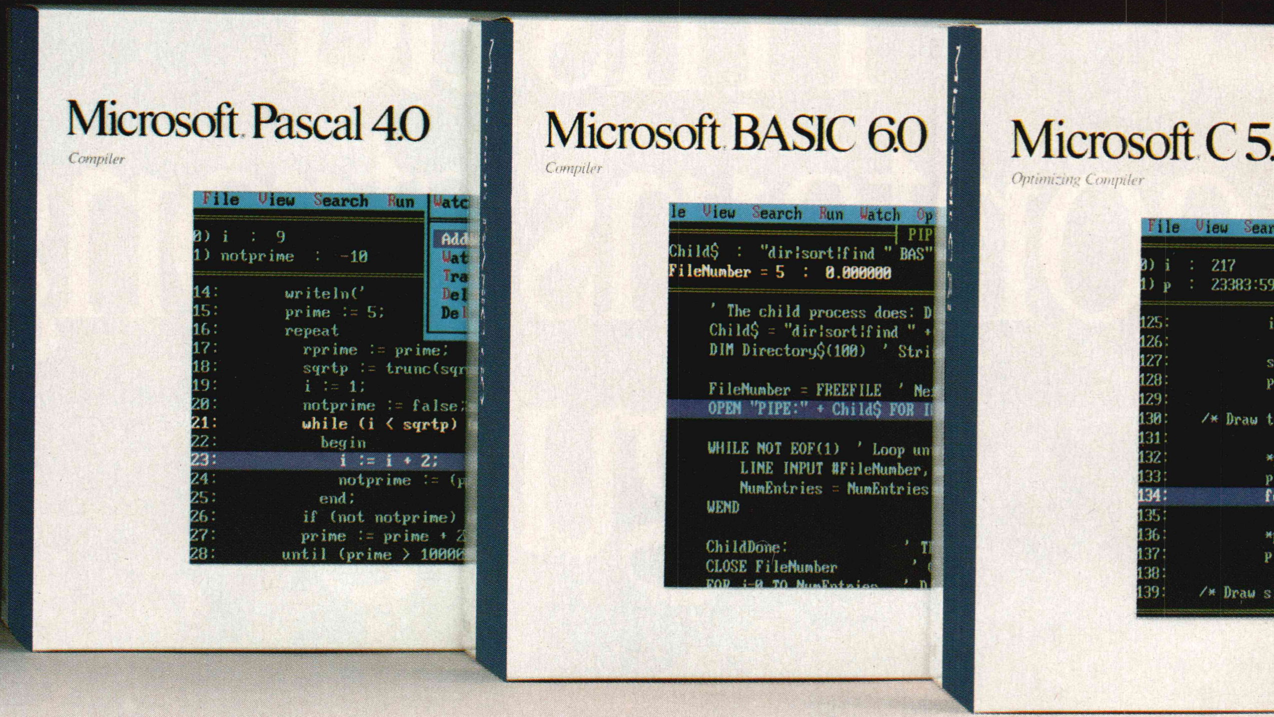

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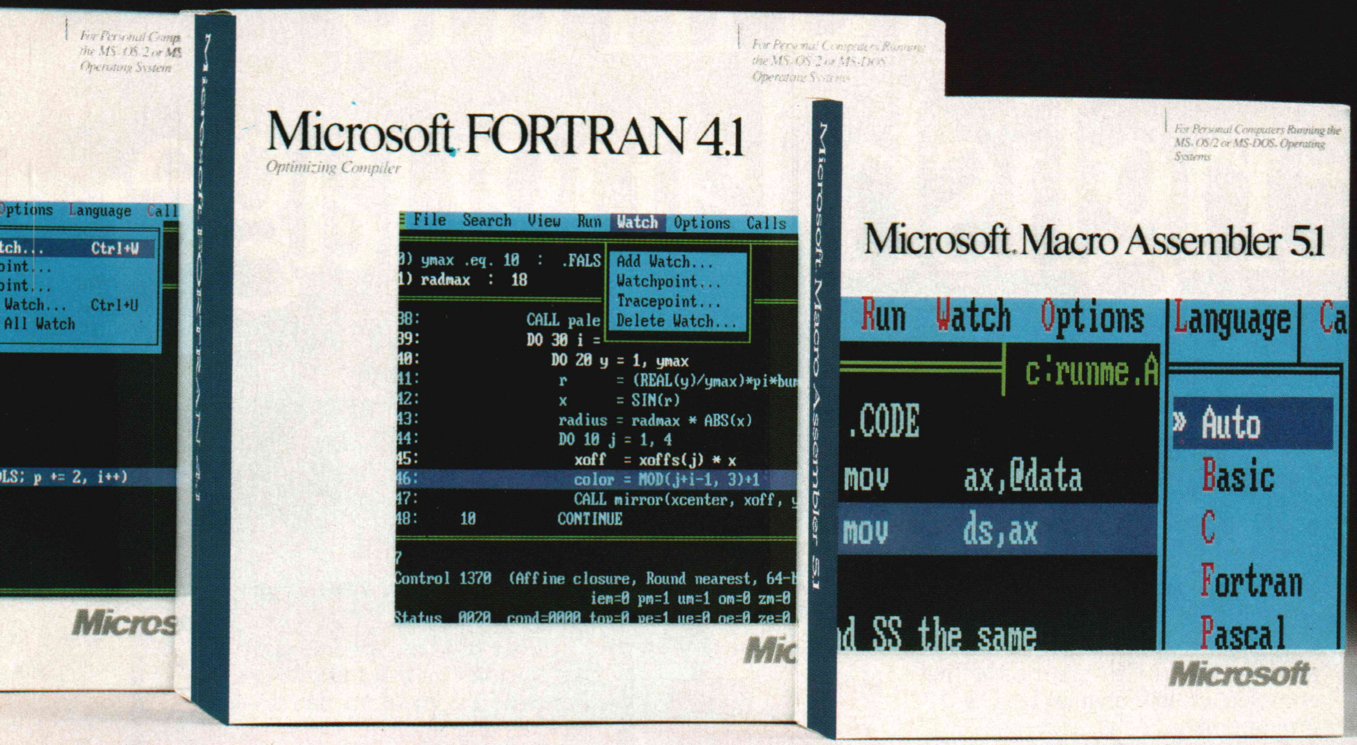

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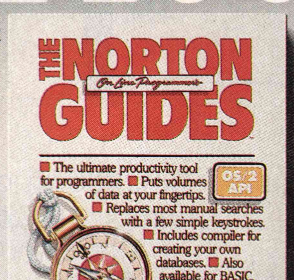

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(continued from page 106)

where f is the percent of the total work that can be done in parallel and p is the number of processors. The value of f cannot be 100 because some communication and control overhead is necessarily not parallelizable. This means that, with five processors and an algorithm that is 75 percent parallelizable, the maximum speedup attainable is only 2.5. Adding more processors will only increase the speedup gradually toward a final limit (for this particular algorithm) of 4.0. Given that communication overhead can increase rapidly with the number of processors in an MIMD system, the value of additional processors drops quickly to nothing in this scenario.

Nevertheless, even large-scale MIMD parallelism is worth looking into. The problem with the scenario just discussed was the 75 percent parallelizability. As the value of f in Amdahl's equation approaches 100, the entire expression approaches linearity; that is, n processors yield an n-fold speedup. There are experimental results showing that in interesting cases near linearity is in fact attainable. For one example, see McBurney's comments in *PARLE, Parallel Architectures and Languages Europe* (Springer-Verlag, 1987).

Relative speedup, which is the speedup due to parallelization minus overhead, approaches linearity as the number of processes (that is, tasks, not processors) increases (but it has to increase a lot). Of course, it is exactly the nonparallelizable overhead that sets the limit in Amdahl's equation; but when, as is the case in a wide variety of problems discussed by McBurney, the overhead cost becomes negligible with increasing problem size, then even large-scale MIMD parallelism suddenly makes sense.

MIMD puts more burden on the application programmer to partition the program into appropriate components for parallel execution. Languages have been developed to facilitate this partitioning, some of them deriving from a model developed by C.A.R. Hoare called Communicating Sequential Processes, or CSP.

CSP

Hoare's model is of two or more independent processes, each consisting of a sequence of instructions executed sequentially. The processes are no different from programs written in any conventional sequential programming language, except when they must communicate with one another. In Hoare's model, this can only happen when each of two processes desires to communicate with the other process, and he calls this synchronization of desires a rendezvous.

Hoare's rendezvous is a strict synchronization, and by itself it would defeat one of the canons of parallelism, which is to keep all processes busy as much of the time as is possible. To free a process that might otherwise be locked up waiting for a rendezvous, Hoare adopted nondeterministic alternation and repetition constructs from Dijkstra.

These nondeterministic constructs require something called a guard, which is a Boolean expression that precedes a command. Only if the guard is true is the command executed, but its truth does not guarantee execution. The guarded alternation construct causes at most one of a set of guarded commands to be

(continued from page 111)

executed, with that one selected at random from those commands with true guards. The guarded repetitive construct causes all commands with true guards to be executed until no guards are true.

Guarded alternation and repetition allow a process, for example, to pass on data to any other available process or to get data for processing any time any other process has data to deliver.

Together, the concepts of sequential processes communicating via rendezvous and nondeterministic alternation and repetition make up a model for MIMD parallelism that is both provable and a solid basis for a programming language. One such language, and the natural one for developing transputer-based software, is occam.

Occam

"Occam's Razor slices things down to simplest causes. Single causes have a fair chance of being right."—from "Occam's Scalpel" by Theodore Sturgeon (*Worlds of IF*, August 1971).

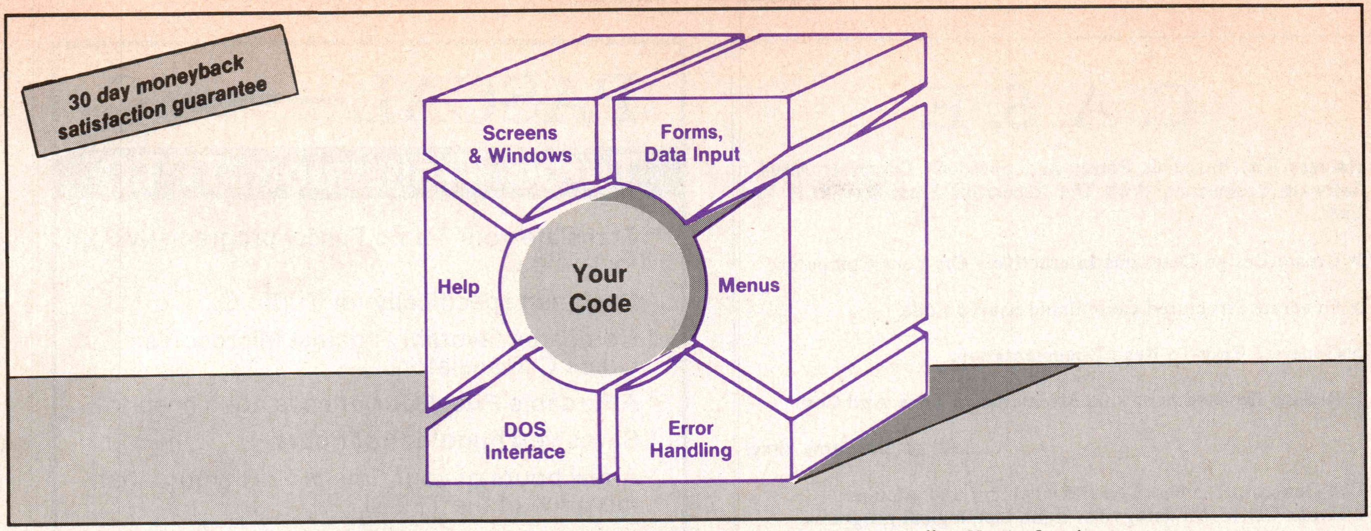
Occam's razor (or sometimes Ockham's razor) is the principle of ontological economy, attributed to William of Ockham (or Occam), circa 1285–1349, an English Franciscan, heretic, and philosopher best known among philosophers for his antirealist interpretations of universals. To the rest of us, if he is known at all, it is for Occam's razor, which states that, in explaining nature, entities should not be multiplied beyond necessity: the simplest explanation is the best.

The programming language occam (with a lowercase *o*) was designed by people at INMOS for writing parallel programs to run on the INMOS transputer processors. Occam supports parallel processing with only a few new programming entities. So clean is the occam implementation that major portions of the occam development system have been formally proved correct.

Occam implements the key concepts of CSP directly by the use of constructors. Sequences of commands (also called primitive processes) are grouped into sequential processes using the constructor *seq*, concurrency among such processes is indicated by the constructor *par*, and nondeterminism is introduced with the constructor *alt*. Nondeterministic alternation and repetition are implemented using the *alt* constructor in conjunction with Pascal-like alternation and repetition constructs such as *if* and *while*. Communication between processes follows the CSP rendezvous model, with two processes choosing a common channel on which to signal or pass data.

Although occam is a high-level language, it is also in some sense the machine language of the transputer, which was designed using occam. The two are closely linked. In particular, occam processes are run on individual transputers, and occam channels map directly onto the physical transputer links.

In Example 1, page 115, I give a taste of occam code. The three processes INPROC, BUFFPROC, and OUTPROC run in parallel, with INPROC gathering data and passing it to BUFFPROC, which in turn passes it to OUTPROC for output. Communication between processes in CSP occurs at a rendezvous and there are two in this example: when BUFFPROC calls INPROC and vice



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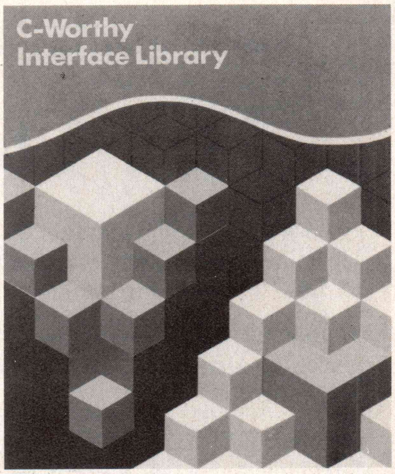

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(continued from page 112)

versa, and when BUFFPROC calls OUTPROC and vice versa. Note that indentation is not optional in occam.

I hope this taste of parallel paradigms has been useful and entertaining. Thinking through parallel approaches can be enlightening even if you never expect to work on a parallel system. Several programmers have pointed out the possibilities for learning new sequential approaches from studying parallel techniques. And it adds to your paradigmatic breadth.

WHOOPS, or What is Object-Oriented Programming?

One programming paradigm that has become extremely popular of late is object-oriented programming. *Object-oriented* is the current vogue word, displacing *structured* as synonymous with whatever is good and true and beautiful in programming. Smalltalk, Actor, Simula67, and C++ are described as object-oriented; there have been claims that Ada, LOOPS, and APL are object-oriented languages; and there is much talk of object-oriented design in Pascal, Modula-2, C, and Forth. Just what is the object-oriented paradigm? What features does a language need to have in order to be said to support the paradigm? And what does it mean to say that one is programming in the paradigm?

Bjarne Stroustrup has come up with a set of definitions that help to clarify the issue, at least if you accept them. I do, chiefly because they give a clear picture of object-oriented programming as a paradigm, indicating what kinds of puzzles the universe sets an object-oriented programmer.

Stroustrup takes pains to distinguish the object-oriented paradigm from the paradigms of data hiding and data abstraction. Data hiding, he says, boils down to using modules. You can achieve the effect of data hiding in C, but Modula-2 makes the module a fundamental language construct. Stroustrup says that Modula-2 supports data hiding but C only enables it.

Data abstraction according to Stroustrup means programming with user-defined types. Any programming language that provides the means for doing this supports the data abstraction paradigm—Ada and C++, for two examples.

One thing that the data-abstraction paradigm does not permit is expressing a distinction between the properties of a type and the properties of instances of the type. Object-oriented languages, Stroustrup says, are those that support expressing this distinction, such as Smalltalk. The mechanism for doing this is inheritance.

Object-oriented programming is, for Stroustrup, just programming using inheritance, and it is, roughly, a superset of the other paradigms. Smalltalk is certainly an object-oriented language, or rather an object-oriented environment. (Strictly speaking, no language can be object-oriented by itself; object-oriented programming requires support from a programming environment as well as support from a language.) I'm not sure where this leaves HyperTalk, which seems to have an inheritance structure but which does not allow creation of new types of objects. In any case, he breaks down the object-oriented paradigm further, as follows:

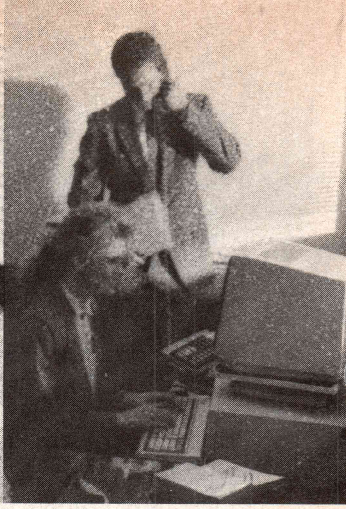
- decide which classes you want
- provide a full set of operations for each class
- make commonality explicit by using inheritance

The benefits of the object-oriented paradigm come from the exploitation of the commonality among types, and identifying commonality

```
INPROC::

        ...
        (* input X*)
BUFFPROC ! X

        ...

OUTPROC::

        ...

        BUFFPROC ? X
        (* output X *)
```

Example 1: *Communicating processes in CSP.*





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PROGRAMMING PARADIGMS

(continued from page 115)

in the problem is the chief task that the paradigm sets the programmer.

Stroustrup's definition of object-oriented programming is not the same as David Robson's in Robson's classic *Byte* article of August 1981, in which he presents the class/instance distinction (and consequently inheritance) as optional. But Robson seems to be defining a concept rather than a paradigm. It also does not match Brad Cox's view of the centrality of the software IC metaphor to object-oriented programming. And it is at variance with Geoffrey Pascoe's view, expressed in *Byte* in August 1986 that information hiding, data abstraction, dynamic binding, and inheritance are all defining features of object-oriented programming. But Stroustrup argues that information hiding and data abstraction are subsumed within inheritance.

One thing that Stroustrup's definition does provide is a picture of the kind of puzzles the object-oriented programmer faces as a result of being an object-oriented programmer. The object-oriented programmer selects a set of classes, provides operations for each class, and then sets out to identifying commonality in the problem in order to make it explicit by using inheritance.

It's explicitly a definition of object-oriented programming as a paradigm.

Availability

All the source code for articles in this issue is available on a single disk. To order, send $14.95 to *Dr. Dobb's Journal*, 501 Galveston Dr., Redwood City, CA 94063, or call 415-366-3600, ext. 221. Please specify the issue number and format (MS-DOS, Macintosh, Kaypro).

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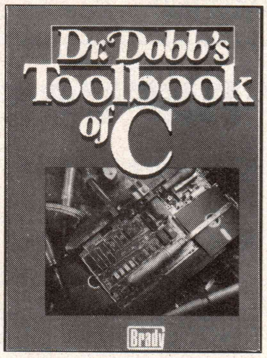

by the Editors of
Dr. Dobb's Journal
of Software Tools

This authoritative reference contains more than 700 pages of the best C articles and source code from Dr. Dobb's Journal of Software Tools, along with new material by C experts. The level is sophisticated and pragmatic: appropriate for professional C programmers. You'll find hundreds of pages of useful C source code, including a complete compiler, an assembler, and text- processing utilities. Highlights include:

- James E. Hendrix's famous Small-C Compiler and New Library for Small C
- Also, James E. Hendrix's Small Mac: An Assembler for Small C and Small Tools: Programs for Text Processing
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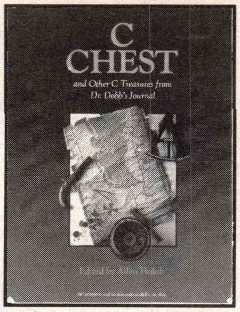

by Allen Holub

This comprehensive anthology contains the popular "C Chest" columns from *Dr. Dobb's Journal of Software Tools,* along with the lively philosophical and practical discussions they inspired, plus other information-packed articles by C experts.

Topics covered include: pipes, wild-card expansion, and quoted arguments; sorting routines; command-line processing; queues and bit maps; utilities such as ls, make, and more; expression parsing; hyphenation; IBM cursor control and an Fget that edits; redirection; accessing IBM video display memory; trees; an AVL tree database package; directory traversal; sets; shrinking .EXE file images; hashing, expressions, and roman numerals; and statistical applications of digital low-pass filters.

Other treasures include: a variable metric minimizer; Fgrep; a peephole optimizer; and curve fitting with cubic splines.

All subroutines and programs are written in C, and are available on disk with full source code. MS-DOS format.

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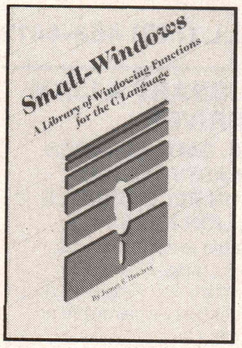

by James E. Hendrix

Small-Windows is a complete windowing library for C (Microsoft 4.0/5.0, Turbo C 1.5, Lattice C 3.1, and Small-C). The package includes:

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A file directory facility illustrates the use of window menu functions and provides file selection, renaming, and deletion capability. Two test programs are provided as examples to show you how to use the library and the window, menu, and directory functions.

The **Small-Windows** package is available for MS-DOS systems, and Microsoft C Version 4.0/5.0, Turbo C1.5, Lattice C 3.1and Small-C compilers. Documentation and full C source code is included.

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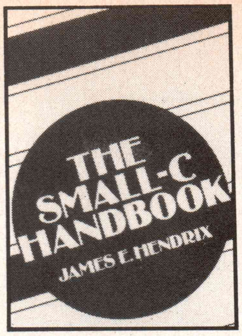
A Small-C Compiler: Language, Usage, Theory, and Design



by James E. Hendrix

This book contains a full presentation of the design and theory of the Small-C compiler and programming lanaguage. Full source code is included. In addition to a full, working Small-C compiler, this book provides an excellent example for learning basic compiler theory. Some of the features implemented include: recursive descent parsing, a one-pass algorithm, and the generation of assembly language code. You'll even learn how the compiler can be used to generate a new version of itself.

All sample programs are available on disk with full source code. A Microsoft or IBM Macro Assembler is necessary.

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C Programming for MIDI

by Jim Conger

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Author Jim Conger begins by outlining the features of MIDI (Musical Instrument Digital Interface) and its support of real-time access to musical devices. An introduction to C programming fundamentals as they relate to MIDI is also provided. The author fully demonstrates all these concepts with two MIDI applications: a patch librarian and a simple sequencer. Some of the fundamental MIDI programming elements you'll learn are:

- full development of a patch librarian program
- sequencing applications for the MPU-401 interface
- how to create screen displays
- how to write low-level assembly language routines for MIDI
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Turbo C:
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by Stephen R. Davis

Overflowing with example programs, this book fully describes the techniques necessary to skillfully program, optimize and debug in Turbo C. Every topic and Turbo C feature discussed is fully demonstrated in Turbo C source code examples. Advanced topics such as pointers; direct screen I/O; inline statements in Turbo C; and how to intercept and redirect BIOS calls are all covered in depth. The author further demonstrates these advanced topics by writing a RAM resident pop-up program in Turbo C. In addition the author fully outlines the differences between Unix C and Turbo C; the transition from Turbo Pascal to Turbo C; and the superset of K&R C features implemented in Turbo C and included in the proposed ANSI C standard.

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Let's face it, screen layout and data validation are a drag. Most serious PC applications probably devote over half the code—and well over half the development effort—to tweaking displays and protecting the user from the GIGO syndrome.

Golden Solution's PC/Forms was designed to reduce this tedium and it does! In 15 minutes to half an hour, you can design a display, set up elaborate input validation criteria, test the form interactively, and generate the code to implement it. Writing and testing the equivalent source code from scratch could easily take several days.

The Turbo Pascal and C versions of PC/Forms are comprised of different sets of tools. We tested the C version, so that's what we'll talk about here.

The heart of the product is a stand-alone editor called FORMS. You run it to set up the display and validation and to generate the files used by your application. FORMS has bouncing-bar menus`a la Lotus 1-2-3. It's a highly visual environment, with windows popping up all over the place and pick lists and such, all of which have an intuitive feel. In layout mode, you paint your form on the display using function keys and the usual editing commands. There are commands for centering text, drawing boxes and lines, highlighting, rearranging, and so on.

When you're happy with the layout, you pick Attributes from the main menu, then cycle through the fields assigning validation parameters. Figure 1, below, shows the extent of the options available: picture, data type, decimal precision, mandatory response, and so on. A particularly intriguing option is aux edit, which ties a user-supplied routine to a field so that you can provide validation above and beyond the capabilities offered by PC/Forms.

The test selection from the utilities menu simulates a data entry session. You can step through the form, making sure the validation criteria work and that the order of fields is right. If not, you can jump back to the editing tools and fix it without leaving FORMS. This is a particularly handy feature.

When all is well, you generate two files. One is a .FRM file, a descriptor file for the form, which we'll discuss later. The other is an application shell in generic C. It's by no means a complete application, but it contains a data structure for the fields and all the code to load and execute the form (which is only about six lines). The shell is suitable for editing and insertion into a program as a function.

The other major component of the software is a header file and a runtime library. PCFORMS.H defines the data structures, function prototypes, and what not used by PC/Forms. You include it in your source program and link the object code with the runtime library.

There are actually three runtime libraries, one for each supported C compiler (Borland, Lattice, and Microsoft). You copy the one you need from the delivery diskette. They're

```
PC/Forms Version 1,2                           ©Copyright1987 Golden Software

  Single All
  Assign attributres to all fields

  Name: ADDRESS    Order;  4 Offset;    39 Rwo;  9 Col; 12 Len;      27

  Edit Mask;
  X
  Default Value;
  Auto Tab;           y   Right Justify;   N   Display Only;   N
  Must Respond;       N   Echo Data;       Y   Upper Case;     N
  Aux Edit Code;      0   Test Range;      N   Warning Only;   N
  Numeric Test;       N   Data Type;       S   Pecision;       0

           Lower Bound;       0,00    Upper Bound;   0,00

  [F1] Help  [F2] Display Field  [F3] Next Field  [F10] Return to Menu
```

Figure 1

Ron Copeland, associate editor for DDJ, is the coordinator for this review section. He welcomes your feedback on products worth reviewing.

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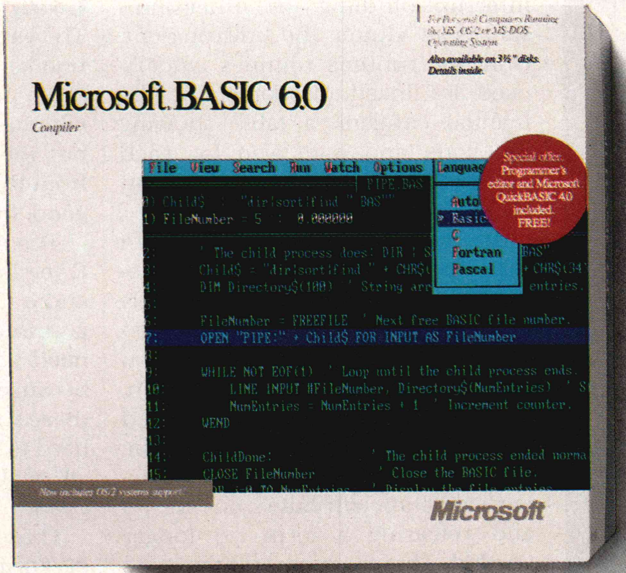

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OS/2 Features
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- OS/2 language additions such as SHELL, OPEN PIPE, ON SIGNAL and SLEEP.
- First programmer's editor that lets you write both OS/2 and MS-DOS programs.

CodeView Features
- Trace execution, set breakpoints, set watch variables, view source code, see data automatically updated as variables are displayed.

BASIC language features
- Fastest stand alone, multiple module executable with no runtime fees.
- User defined event trapping.
- Multiple module error handling.
- Supports records, recursion, huge arrays.
- Additional data types—4 byte integers, fixed length strings.
- Supports all major structured programming constructs including SELECT CASE and FUNCTION procedures.

Microsoft®

(continued from page 122)

all small models. Golden Software includes source code for the runtime system, so if you need a different model, you can recompile appropriately.

Everything your application needs in order to use PC/Forms is linked into the .EXE file. There's no separate runtime support package, TSR, interrupt-diddling, or other nuisances to clutter the environment. Only the runtime routines actually used are linked, of course, and the manual contains a table showing the code and data size for each routine. The average size is about 1K in a range of 14 to 3,974 bytes.

All identifiers have the form pcf_fname, where fname is something like "display_form" or "error." The pcf prefix makes them distinctive. It takes about half a dozen functions to load and display a form, initialize it, and get the validated input. Other functions among the 17 available do things such as altering validation attributes on the fly and releasing a form no longer needed. There are an additional 23 functions for such things as video and string management.

The .FRM descriptor produced by the FORMS editor is an ASCII file containing information specific to a given form. The runtime system needs it to implement the form and perform validation. Opening a form is a matter of loading this file. You can have several forms open at one time, and any given form can span up to ten pages (display panels). But watch out: the forms go on the stack, and you'll need a mighty big stack if you have several open at once. The FORMS editor has a utility that sizes a form and tells you how much stack space it will require.

The crucial runtime function is pcf_get_form(). When called with a form displayed, it manages user input and validation. The results are placed in a data structure corresponding to the form, whose fields can have user-assigned names. Your program then fetches data from the structure and does its thing with it. This makes the data entry portion of a loop almost ridiculously simple:

```
do {
    pcf_display_form (name, page);
    pcf_clear_form_buffer(&buf, defaults);
    pcf_put_form (&buffer);
    pcf_get_form (&buffer, &Term);
    /* then do data processing */
    while (some_condition);
```

Complaint Department

The vendor ought to include a function key template. Each function key has a purpose and some have an Alt command as well. I finally printed out the function key layout screen from the help system (which is very good, by the way).

The manual needs work. With the C version, you get the Pascal manual and a C addendum. The addendum is printed on yellow paper and you need a magnifying glass to read it because the print is so small. And there's no index, an omission that's hard to forgive even though the overall quality of the documentation is good.

These quibbles notwithstanding, PC/Forms is a real gem. It can truly save countless hours of programming, which makes it a contribution to productivity that will pay for itself many times over.

by Kent Porter

DE

Product:
DE, Version 1.2
Target:
IBM PC, IBM AT, IBM PS/2, and compatibles
Requires:
One floppy; 256K
Pricing:
$75
Vendor:
David Livshin
26 Niles Rd.
Randolph, MA 02368
617-986-7491

I don't know what DE stands for, the manual doesn't say. Were I to hazard a guess, however, I'd say it means "deluxe EMACS."

DE is a stretched version of the

(continued from page 124)

standard EMACS editor. It delivers a host of impressive features that make it a macro-programmable, customizable editor with an unlimited number of overlapping and/or tiled windows.

Unlike competing editors such as Brief, DE doesn't require a bunch of support files. It comes as a single 69K .EXE file on the delivery diskette, and installation is as simple as copying that file to your hard disk or work floppy. To invoke the editor, just type DE. Up to two command-line arguments are allowed: a -NOBAK switch to tell the program not to make a backup copy of the edited file(s), and the name of a file to be edited.

If you want to pull several files into different windows, you can fetch them after DE is up and running. The command ^X^V causes the program to prompt for a filename, then creates a new window and loads the file into it. You keep doing this until all the files you want are loaded.

Initially the windows are tiled. Each one has an information line at the bottom showing the associated filename, cursor position, number of lines, and so on, and most significantly, the window number. Various keystroke combinations let you move sequentially forward and backward among windows or jump directly from one to another. Other commands resize and drag windows so that they overlap like pieces of paper: the now familiar desktop metaphor. In overlapping mode, the current window is always on top.

If you don't like the hierarchy of windows, you can change the sequence numbering. This is a nice touch. You can make the modules you're working on neighbors in the hierarchy; it takes fewer keystrokes to move among adjacent windows than to make jumps.

The command ^X 1 does a thing called zoom and rise to the currently selected window. This changes the operation of DE by expanding each window to full-screen size and placing the current window on top. Oddly, the jump-to-next and jump-to-previous commands (^X n and ^X p) don't work any more in this mode; you have to jump to a specific window. And there's no way that I found to undo the zoom-and-rise mode. Once you're in it, you're there to stay.

EMACS commands in general are less than intuitive, and DE continues the tradition by adding still more to the repertoire. All DE commands except those dealing with editing and cursor movement begin with either ESC or ^X, followed by a keystroke denoting the command. Some make sense (^X^I to insert a file, ^X^W to write to a file, and so on), but most have no discernible connection with anything. Examples are ^__ to invoke the DOS shell, and ^X z and ^X^Z to enlarge and shrink a window, respectively.

Consequently, the vendor in-

(continued from page 127)

cludes a cheat sheet showing all the keystroke commands. There's also a limited help function: type ESC ^A, then a keystroke combination, and DE tells you what function the combination performs.

Each keyboard command is mapped to a DE macro through what the vendor calls "default binding." For example, ^X^S is bound to the macro w_cfil, which writes to the current file. This association of keystrokes to macros opens the way to two features of DE: customization of the keyboard and programmability.

DE comes with 84 different macros, of which 73 are bound to default keystrokes and the other 11 (all of them related to window management) are unassigned. If you don't like the default bindings, or you want to add some bindings of your own, the command ESC ^@ runs an embedded utility that maps keystrokes to macros.

You can build your own more complex macros by combining those built into DE, thus creating editor programs invoked by a keystroke. Seldom needed programs can be stored in separate ASCII files and run with the ESC e command, which asks for the filename, loads it, and treats the contents as commands. Unfortunately, the manual barely glances at this useful feature.

Also alluded to but never explained in the manual is something called the DE.INI file. It presumably contains initialization commands that permanently map macros to keystrokes and perform other fixed set-up tasks.

It's a pity that the DE manual is not up to the quality of the software it purports to describe. A slim 26 pages, it contains terse descriptions of the macros, a little about windows and commands, and not much of anything else. The author assumes that you already know EMACS, and so leaves it to your imagination how to use the editor and its features. There isn't even a hint of a tutorial. The best part of the documentation is the cheat sheet, which puts most of the manual's contents on a card providing at a glance reference.

Overall, DE is a good editor with a lot of capability per buck.

by Kent Porter

Soft-ICE

Product:
Soft-ICE, Version 1.01
Target:
80386-based MS-DOS computers
Requires:
DOS 2.0 or later; AT BIOS
Pricing:
$386
Vendor:
Nu-Mega Technologies
P.O. Box 7607
Nashua, NH 03060-7607
603-888-2386

Soft-ICE is a product any MS-DOS developer serious enough to own a 386 machine should have. As the name implies, it provides the capabilities of an in-circuit emulator via software. For those of you not familiar with in-circuit emulators, a brief description is in order.

An in-circuit emulator (ICE) is a tool that replaces the CPU in a microprocessor-based product with a "pod" that plugs into the CPU's socket. This pod is normally connected to a box containing a control computer and some special hardware. The special hardware is used to detect user-specified conditions and to stop the processor when they occur. Another feature commonly found in ICEs is trace memory, so that when the processor stops, you can see where it has been recently. ICEs are normally expensive, and often designed more for debugging hardware rather than debugging software.

Soft-ICE gives 386 owners all of this capability, except trace memory, when debugging MS-DOS programs. It does this by using special features of the 386 normally used in writing operating systems (see February, 1988 *DDJ* for more details). Note that you can't use Soft-ICE to debug protected mode programs.

Soft-ICE can be used either stand alone or in conjunction with your favorite debugger. As a stand-alone debugger, it includes all of the necessary commands to disassemble, dump, and edit memory; to display and change registers; to peek and poke at I/O ports; and to manage breakpoints. A very useful help facility is also included, as well as a command to display the DOS system memory map. As you type commands, Soft-ICE displays a list of options.

Getting all the Breaks

Perhaps more than any other debugger, Soft-ICE lets you control breakpoints. You can set breakpoints to occur when any byte, word, or double word is read, written, read or written, or executed. For read/write breakpoints, you can include a qualifying value that must be matched or not matched. Breakpoints may be configured against a larger address range such that a breakpoint occurs on any read, write, or read or write in the range. I/O port accesses can cause breakpoints, qualified by values if desired. Execution of either a hardware or software interrupt (qualified by a value in AL, AH, or AX if desired) can cause a breakpoint. Of course, each of these breakpoints may be qualified with a count so that you can ignore the first 100 times you do any of them. You can even combine breakpoints so that a breakpoint only occurs after all of the selected breakpoints have individually occurred. Finally, breakpoints may be qualified with the location of the breaking instruction, to guarantee that the instruction is either inside or outside a range. All in all, a very comprehensive set of breakpoint capabilities, all of which can be used either stand alone or

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with another debugger.

If all of this isn't quite enough, you can configure Soft-ICE to generate a software interrupt when it detects a breakpoint. This user-provided interrupt gets all of the registers as they were when Soft-ICE got control, allowing the interrupt handler to do anything it likes.

When used with another debugger, Soft-ICE can be configured to trigger the other debugger when a Soft-ICE detected breakpoint occurs. It can cause an interrupt 1 or 3, or an NMI. Soft-ICE normally passes interrupt 3 onto whatever awaits it, but it can also be configured so that an INT3 returns control to Soft-ICE.

Soft-ICE is very flexible. It may be installed in normal memory, in extended memory, or in COMPAQ extended memory. If Soft-ICE finds extended memory it will automatically load there requiring none of the lower 640K. In a machine with only 640K, the program demands between 56 to 60K, rendering this segment 60K invisible to DOS.

Soft-ICE can share extended memory with other drivers, such as VDISK or RAMDRIVE. It emulates the necessary parts of the LOADALL instruction for RAMDRIVE. You can change the keystrokes used to invoke Soft-ICE. It can even boot up stand-alone code and debug it because Soft-ICE doesn't require any DOS services. Soft-ICE can also be used to debug MS-DOS device drivers. And, joy of joys, you can even debug interrupt handlers (including the keyboard interrupt) while Soft-ICE is using it.

The documentation is solid and tells you everything you need to know in about 100 pages. A tutorial chapter takes you through debugging, a simple program and is highly recommended for both beginners and those already experienced in debugging. [It does however require an IBM or equivalent for the BIOS routines. —ED]

All in all, Soft-ICE is an excellent tool for debugging 8086 programs. Compared to a true in-line emulator, (even if you have to buy a 386 machine to run it on) it's cheaper and provides superior breakpoint facilities; the only thing missing is a trace memory.

by Richard Relph

DDJ

Object-Oriented Engineering

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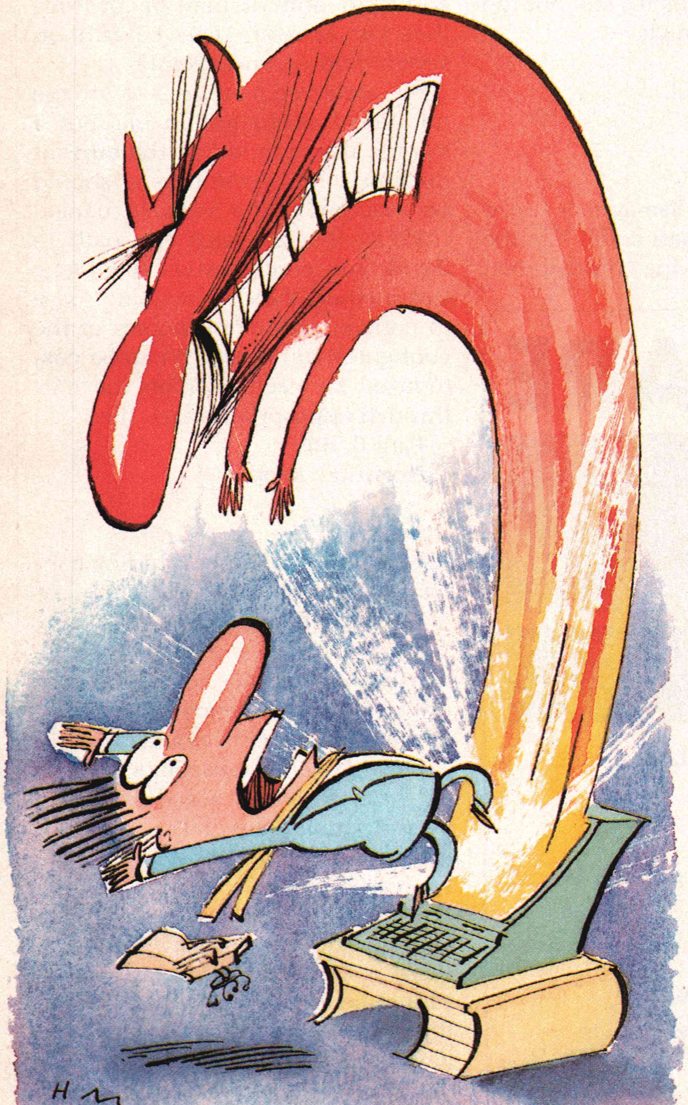

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(continued from page 14)

Compatibility Standards

Dear *DDJ*,

I've been thinking lately about how unfortunate it is that there is so little standardization in the computer industry, making it impossible to run programs written for one machine on another. I have an idea that could alleviate some of the compatibility problems, and I'd be interested in readers' responses to it.

The idea is this: Design a standard intermediate language, similar to a language that would be generated by the syntax-analysis pass of a compiler (for input to the code generator). Then, use this new language as the form in which software is distributed for use on computers, instead of as native code that is specific to a particular system. The program loader on each computer would recognize the special intermediate-language file and invoke a fast code generator to translate it to native code prior to beginning execution.

There are problems with this—one being that different systems have different capabilities and different hardware. Most systems, however, have a display device that can display ASCII characters and a printer. For many programs this is all that is needed. The intermediate language could include instructions to determine the capabilities of the system (for example, display size), allowing the program to adapt to different machines.

Another problem is that the program distribution medium is different for different systems. Even computers that use floppy disks typically each have their own disk format. This is indeed unfortunate, and manufacturers should be severely taken to task for not standardizing disk format. Perhaps it's still not too late to do this, though.

Ted Toal
Nevada City, Calif.

LAN Security

Dear *DDJ*,

It was with some dismay that I read Allen Holub's C Chest column in the February issue. Saving configuration information in the .EXE file is the easiest way I know of to discourage the use of a program on a local-area network. If users must be able to write to the .EXE file to use the program, then the program becomes a hole in system security, an opening for Trojan horse programs. Second, if users need to write to the .EXE file, multiple instances of the program cannot be run at the same time.

Often a program that has not been written with the LAN environment in mind may be used on a LAN with no modification, provided that the program may be configured dynamically. If the program may be run when its file attributes are shareable and read only, it may be possible that the program can be run on several nodes concurrently.

My preferred method is to use the traditional configuration file, but if the file is not found in the current directory, the environment should be searched for a variable named *CONFIG* that contains the path to the default configuration file. Using this method the disk does not have to contain redundant copies of the configuration file, but it can be customized for each user on the LAN through appropriate batch files.

Paul B. Hill
Norwood, Mass.

Dear *DDJ*,

Allen Holub's method of hiding configuration information in an application's .EXE file (C Chest, February 1988) is elegant and quite instructive, but I would like to raise a point or two in favor of keeping configuration information in separate files.

Most shared applications on a local-area network are located in shared public directories that are accessed via the DOS path or an equivalent network function. Users of the shared applications are usually granted read-only access to these public directories. Most users cannot be allowed to modify files in the public areas as this would be an invitation to disaster. Application programs that write into their own .EXE file do not work well under these circumstances and can cause LAN managers severe headaches. The re-

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Robert Lerche, Bay Partners.

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Robert Wenig, Autodesk.

"Our software is running anywhere from 30 to 50% faster than when compiled under Lattice." **David Marcus, Micronetics.**

"We switched from Lattice due to a 10% reduction in code size. The compiler is very stable." **Lee Lorenzen, Ventura Software — Ventura Publisher, marketted by Xerox Corp.**

"Best quality emitted code by any compiler I've encountered. Often amazing." **Bill Ferguson, Fox Software — FoxBase (386).**

"Messages sometimes pointed out type mismatches, incorrect-length argument lists, and uninitialized variables that had been undetected for years [in 4.x bsd]." **Larry Breed, IBM ACIS [RT PC].**

"Diagnostics turned up bugs missed by other compilers. Rapid bug fixes by technical support, someone who knew what he was talking about. 80386 code is well optimized."
Tim Addison, Logistics Data Systems.

"386 protected mode support is fantastic, especially the access to large amounts of memory. It's mainframe compute power on a PC." **Dan Eggleston, Viewlogic.**

"The preprocessor supplied with Professional Pascal is quite useful. The code quality and control over segmentation and memory models are superior to MS Pascal." **Bob Wallace, QuickSoft.**

Check Out These Reviews

- **High C ™:**

Computer Language	February 1986, '87	
Dr. Dobb's Journal	August 1986	
PC Magazine	Jan. 27, 1987	(80386 version)
Dr. Dobb's Journal	July 1987	(80386 version)
BYTE Magazine	November 1987	(80386 version)

- **Professional Pascal ™:**

PC Magazine	Dec. 29, 1985	
Computer Language	May 1986	
PC Tech Journal	July 1986	
Journal of Pascal, Ada, & Modula-2	Nov.-Dec. 1986	
BYTE Magazine	Dec. '86, June '87	(80386 version)

Why MetaWare compilers

- They are specifically designed for serious software developers.
- They are reliable and robust: they don't break at every turn.
- Their generated code is the best, or near best, on each architecture.
- Their superior diagnostic messages help you produce better products more quickly.
- Your source can be ported with ease to the most popular systems.
- You can link mixed-language modules from our compilers, others
- You can benefit from high-level, personal technical support.
- You can take advantage of the latest ANSI C extensions, and/or extensive Pascal extensions. **High C** has been tracking the ANSI Standard for two years; **Professional Pascal** will soon have a VS Pascal compatibility switch and several Apollo Pascal ext'ns.
- You can take advantage of the latest 387 and Weitek 1167 support — we have the only compilers with Weitek real mode support.

Power Tools for Power Users

Ashton-Tate: dBase III Plus, MultiMate; Autodesk: AUTOCAD, AUTOSKETCH (8087, '387, Weitek); Boeing Computer Services (Sun); CASE Technology (Sun); CAD/CAM giant Daisy ('86, '386, VAX); Deloitte Haskins & Sells; Digital Research: FlexOS; GE; IBM: 4.3/RT, 4680 OS; Lifetree Software (Pascal): Volkswriter Deluxe, GEM-Write; Lugaru: Epsilon; NYU: Ada-Ed cmplr; Semantec: Q&A; Sky Computers; ... (Product names are trademarks of the companies indicated.)

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A Partial List of Optimizations

Common subexpression and dead-code elimination, retention and reuse of register contents, jump-instruction size minimization, tail merging (cross jumping), constant folding, short-circuit evaluation of Boolean expressions, strength reductions, fast procedure calls, automatic mapping of variables to registers (where advantageous), ...

"Platform" — Code Quality

Sun,Apollo,SGI	— 18%, 3%, 26% > resident compiler (Dhrystone).
PC: DOS, OS/2	— 3-10% > Microsoft C; 30% > MS Pascal, LatticeC.
386 32-bit DOS	— no competitors, since November, 1986.
286, 386 UNIX	— 66% better than pcc (Dhrystone, 386).
VAX VMS	— ≈ DEC's excellent C and Pascal; better features.
VAX Ultrix	— 19% > pcc (Dhrystone); much > Berkeley Pascal.
RT PC/4.3bsd	— 89% > the original port of pcc (Dhrystone).
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(continued from page 132)

sult is that you end up with several complete copies of the application program scattered about.

It is possible for a LAN manager to arrange for the proper storage of an application's configuration file if the program is designed with some thought to the problem. I believe the best way to handle the location of the configuration file is for the application to accept a command-line parameter that points out the complete path where the configuration file is located.

The LAN manager usually has methods of setting environment variables when users log on to a LAN that can specify user names of physical workstation numbers. These environment variables can then be used with shared public batch files to execute the application and specify the appropriate configuration file for a particular user or workstation. It is useful to be able to specify a configuration file in association with a physical workstation because most networks have a variety of workstation hardware.

The programs that are most convenient to install and use on local-area networks are those that keep things simple. The best applications are often those that consist of a single .EXE file with no other external files. These are also the programs that LAN managers will purchase in quantity rather than those applications that cause difficulties in configuration, installation, and maintenance. Most of the software currently used on LANs are not the large expensive packages that do strange tricks with configuration and security information but the same simple single-user products that work so well on Personal Computers.

Phillip M. Nickell
Longmont, Colo.

Was He Misguided?

Dear *DDJ*,

I was happy to see the review of The Norton Guides (Examining Room, February 1988); however, I was reminded of these words by Lewis Mumford in the *Pentagon of Power*: "Unfortunately, 'information retrieving,' however swift, is no substitute for discovering by direct personal inspection knowledge whose very existence one had possibly never been aware of, and following it at one's own pace through the further ramification of relevant literature. But even if books are not abandoned, but continue their present rate of production, the multiplication of microfilms actually magnifies the central problem—that of coping with quantity—and postpones the real solution, which must be conceived on quite other than purely mechanical lines: namely, by a reassertion of human selectivity and moral self-discipline, leading to continent productivity. Without such self-imposed restraints the over-production of books will bring about a state of intellectual enervation and depletion hardly to be distinguished from massive ignorance."

As a reasonably happy owner of The Guides, I eagerly dug into the review, which upon reading, I'm afraid to say seemed like a cursory tidbit that I had not expected to find in *DDJ*. I feel there are three major problems with it:

1. I originally thought that the 37K memory residency TSR requirement was a gnomish munchie, but after looking at the 38K file size on my floppy, I thought there was definitely a mistake here. I have run this program on both an IBM PC and an IBM AT compatible with PC-DOS/MS-DOS, and it takes up 71,920 bytes installed.
2. One of the original problems with the advertising, and especially on the box my program came in, was the reference to being able to run it on a floppy-disk-based system. This is possible if you have drives that hold more than the 600K needed for either the MASM or C database. A hard disk is probably required rather than recommended, unless you wish to write your own or just use a BASIC database. I was not pleased to find that the assembly-language database would not run on my IBM PC floppy system. The review made no mention of this possible predicament.
3. One of the most useful aspects of the program is the capability of The Guides (given the right active menu) when initially activated to do an automatic lookup of the entry for the word by the cursor. It's a handy feature to have enabled but nary a mention of it in the review.

I would think that if you're going to do these reviews, you need to have people to do them who have more than a passing interest in the material. As the ultimate end-user of some of this software, I'd like to get information other than what I can get from ads and the users' booklet. I'd also like to see how the product compares with others that purport to do the same thing but cost less.

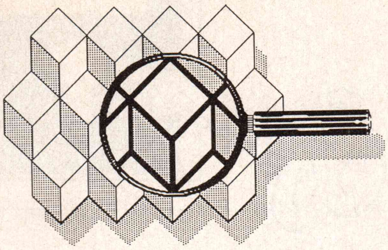
Richard L. Henley
via CompuServe

Kent Porter responds:
Let's go by the numbers:

1. We're both wrong according to CHKDSK; it takes 72,032 bytes on my AT. The NG.EXE file is 37K, not RAM resident.
2. Good point. I haven't run it on a floppy-based system, but Richard's point makes sense because the databases are large.
3. Auto-lookup is indeed a dandy feature. If it got short shrift, it's because space in these reviews is limited.

DDJ

OF INTEREST



Products for Developers

Dan Bricklin's Demo II Program is now available from **Software Garden**. This new version comes with a 220 page manual, keyboard templates, an on-line tutorial, and sample files. New features include the ability to capture bitmapped graphics images from other programs, string and numeric variables, and a run facility with over 100 new actions to execute while running. Demo II also comes with a license to make an unlimited number of copies of the runtime. The product runs on 512K IBM PC, IBM PC AT, IBM PS/2 or compatibles using DOS 2.0 or later. A monochrome display adapter, CGA, EGA, VGA, Hercules Graphics Card or the equivalent is also required. Demo II sells for $195. Reader Service No. 20.
Software Garden Inc.
P.O. Box 373
Newton Highlands, MA 02161
617-332-2240

National Design Inc. (NDI) has released Genesis 1024 and Genesis 1280 intelligent PC color-graphics controllers bundled with an implementation of the Computer Graphics Interface (CGI) developed by Nova Graphics International and Metagraphics' MetaWINDOW.

The NOVA*CGI provides software developers a CGI interface that is now resident on the NDI controllers. By executing the CGI on the NDI board, the developer can perform graphics routines 20 to 40 times faster than on a PC using an EGA card.

The Genesis 1024 (a 640 × 480 up to 1,024 × 768, 16 color card), and the Genesis 1280 (a 640 × 480 up to 1,280 × 1,024, 256 color card) use Texas Instruments' 34010 graphics system processor operating at 40 or 50 MHz. The Genesis products also provide expandable memory up to 32 Mbyte.

The Genesis 1024 costs $1,700 and the price of the Genesis 1280 ranges from $2,995 to $3,995, depending on configuration. Reader Service No. 21.
National Design Inc.
9171 Capital of Texas Hwy. N.
Houston Bldg., Ste. 230
Austin, TX 78759
512-343-5055

The C Programming Language, Second Edition by Brian W. Kernighan and Dennis M. Ritchie has been published by **Prentice Hall**. This new edition is based on the draft-proposed ANSI C Standard. The book makes precise the features that were not spelled out in the original definition of C, and states explicitly which aspects of the language remain machine dependent. New features from the ANSI standard, such as function prototypes and the standard library, are also explained. Additional changes in the new edition include a C reference manual, an appendix describing the standard library, and an appendix summarizing changes between the first edition and the draft-proposed ANSI standard. The price of the book is $40 for cloth and $28 for paper. Prentice Hall will continue to publish the first edition. Reader Service No. 22.
Prentice Hall
Prentice Hall Bldg.
Englewood Cliffs, NJ 07632
201-592-2000

The Software Link (TSL) has announced its newly formed Developer Relations program. The program is based around the company's newly released PC-MOS/386 Technical Reference Manual. Participants subscribe for an annual fee of $500 to development support service which includes: PC-MOS/386 Technical Reference Manual and updates as they become available, access to TSL's support line, upgrades of PC-MOS/386, participation in TSL's product certification program and inclusion in TSL's product reference guide, and purchase of one PC-MOS package for development use at a reduced rate. Reader Service No. 23.
The Software Link
3577 Parkway Ln.
Norcross, GA 30092
404-448-5465

World Wide Data has released Charm, a C source application generator. Charm is an integrated application generator for Unix and VMS environments that automatically creates fully documented C source code. Charm's 4GL, dali (data access language interface) is a natural extension of the interactive screen and program generator. All the standard field default and verification options in Charm are dali programs. Reader Service No. 24.
World Wide Data
17 Battery Pl.
New York, NY 10004
718-438-2807

The Renaissance Graphics Device Interface (RGDI) Developer's Kit is a toolkit for software developers that enables them to develop graphics applications that take advantage of the speed of a special graphics processing chip. **Renaissance GRX's** new product includes: Rendition I Advanced Graphics Controller incorporating RGDI, Rendition I user's guide, RGDI programmer's technical reference manual, TI 34010 user's guide, and development software.

The RGDI is a graphics controller interface that allows a software program to send messages to the Texas Instruments TMS34010 Graphics System Processor, a 32-bit, high-speed integrated circuit that is optimized for graphics performance.

For developers who wish to write in assembly language, Renaissance offers an optional accompanying advanced toolkit which includes: TI 34010 debugger and user's guide; TI 34010 assembler package, including an assembler, linker, and simulator; and development utilities.

For developers wishing EGA compatibility, an optional Rendition EGA

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Knowing a little more about you helps us to tailor *Dr. Dobb's Journal* to specific reader interests. Please take a moment to answer the questions below before you return this card for free product information. Thanks very much!

A. Do you design or develop software for professional applications? 1. ☐ Yes 2. ☐ No

B. What type of computer(s) do you use at work? Please check all that apply.

1. ☐ IBM PC or XT
2. ☐ IBM AT
3. ☐ IBM PS/2 (all models)
4. ☐ Other IBM
5. ☐ PC or XT compatible
6. ☐ AT compatible
7. ☐ 80386 computer
8. ☐ Macintosh Plus
9. ☐ Macintosh II
10. ☐ Macintosh SE
11. ☐ Sun
12. ☐ Apollo II
13. ☐ CP/M, TRS-80, or Apple
14. ☐ Other

C. Please estimate the total amount you anticipate spending on new hardware and software (through approval, recommendation, or specifying) in the next 12 months:

1. ☐ $1000 or less
2. ☐ $1000 to 2500
3. ☐ $2500 to 5000
4. ☐ $5000 to 10,000
5. ☐ $10,000 or more

D. Does your organization buy *hardware* from mail order retailers?
1. ☐ Seldom 2. ☐ Occasionally 3. ☐ Frequently

E. Does your organization buy *software* from mail order retailers?
1. ☐ Seldom 2. ☐ Occasionally 3. ☐ Frequently

Please indicate how often you read the following columns:

F. Editorial:	1. ☐ Always	2. ☐ Occasionally	3. ☐ Never
G. Running Light:	1. ☐ Always	2. ☐ Occasionally	3. ☐ Never
H. Archives:	1. ☐ Always	2. ☐ Occasionally	3. ☐ Never
I. Letters:	1. ☐ Always	2. ☐ Occasionally	3. ☐ Never
J. C Chest:	1. ☐ Always	2. ☐ Occasionally	3. ☐ Never
K. The Forth Column	1. ☐ Always	2. ☐ Occasionally	3. ☐ Never
L. To the Macs:	1. ☐ Always	2. ☐ Occasionally	3. ☐ Never
M. Structured Programming:	1. ☐ Always	2. ☐ Occasionally	3. ☐ Never
N. Artificial Intelligence:	1. ☐ Always	2. ☐ Occasionally	3. ☐ Never
O. Of Interest:	1. ☐ Always	2. ☐ Occasionally	3. ☐ Never
P. Swaine's Flames:	1. ☐ Always	2. ☐ Occasionally	3. ☐ Never

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2. ☐ Recommended purchase
3. ☐ Requested more information
4. ☐ Called advertiser
5. ☐ No action

R. Please indicate which of the following languages you use professionally:

1. ☐ Assembler
2. ☐ C
3. ☐ BASIC
4. ☐ Pascal
5. ☐ dBase
6. ☐ Fortran
7. ☐ 4GLS
8. ☐ Cobol
9. ☐ LISP
10. ☐ Prolog
11. ☐ Forth
12. ☐ ADA
13. ☐ Modula-2
14. ☐ APL
15. ☐ Smalltalk
16. ☐ Other

S. Which of the following operating systems do you use professionally?

1. ☐ MS-DOS or PC-DOS
2. ☐ OS/2
3. ☐ Macintosh Finder
4. ☐ Unix or Xenix
5. ☐ Real-time operating systems
6. ☐ Other

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Title ______________________

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May '88: use before August 31, 1988

Dr. Dobb's Journal of Software Tools
FOR THE PROFESSIONAL PROGRAMMER

READER SERVICE

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3. ☐ IBM PS/2 (all models)
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5. ☐ PC or XT compatible
6. ☐ AT compatible
7. ☐ 80386 computer
8. ☐ Macintosh Plus
9. ☐ Macintosh II
10. ☐ Macintosh SE
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Telemarketing Rep./SE/SW USA Cheri Blum (714) 761-0294
Director of Marketing and Advertising Ferris Ferdon (415) 366-3600

OF INTEREST

(continued from page 136)

(REGA) plug-in model is available.

The RGDI Developer's Kit is available for $695. The optional Advanced RGDI Developer's Kit add-on is priced at $495. The REGA option costs $169. Reader Service No. 25.

Renaissance GRX
Cedar Park
2265 116th Ave. NE
Bellevue, WA 98004
206-454-8086

SoftScience Corp. has released its Convenience Plus DOS Front End which is designed for use with IBM's new 3363 Optical Disk. The program is intended for the novice and advanced PC user as a front end to MS-DOS, PC-DOS, and OS/2 and is designed for supporting file management and recovery on the IBM 3363 Optical Disk.

The program features the ability to perform DOS commands and additional commands not available through DOS; the ability to organize and understand the arrangement graphically of the computer; the ability to use the computer without memorizing or typing complicated syntax and language at a faster pace; unusual file recovery and management commands for the IBM Optical Disk; and DOS commands in five foreign languages. Reader Service No. 26.

SoftScience Corp.
Box 42905
Tucson, AZ 85733-2905
602-326-4679

Sourcer, available from **V Communications**, allows programmers to create commented source code and listings directly from RAM, ROM, .COM files and .EXE files. Sourcer creates detailed commented listings and source code directly suitable for assembly. Built-in data analyzer and code simulator resolves data items across multiple data segments, provides detailed comments on BIOS and MS-DOS interrupt calls and subfunctions, and I/O ports. Sourcer also determines proper assembler directives for multi-segment programs. Built in processor filter optimizes code based on instruction set selected, 80286, 80186/88, 8088/86 and V20/V30.

The Sourcer is also available with the BIOS Pre-Processor, which provides the first means to obtain accurate legal source listings for any BIOS. It identifies entry points with detailed in-line comments explaining functions and subfunctions, registers, and other key information.

The Sourcer costs $99.95, the Sourcer with BIOS Pre-Processor costs $139.95. Reader Service No. 27.

V Communications
3031 Tisch Wy., Ste. 200
San Jose, CA 95128
408-296-4224

Blaise Computing has announced ASYNCH PLUS/4.0, a comprehensive set of routines designed for Turbo Pascal 4.0 to give programmers the power to create interrupt driven communications software. The program has a layered design of separately compiled units, with the higher levels building on the lower levels. These routines drive virtually any asynchronous device via the RS-232 ports. ASYNCH PLUS includes low level control and queue maintenance functions written in assembly language and high-level routines written in Turbo Pascal to help programmers develop communication software. Fully documented source code is included as well as a comprehensive indexed manual which gives a general overview for every function category and descriptions of each function. Examples in the manual and full programs on the distribution diskettes serve as illustrations. ASYNCH PLUS is priced at $129. Reader Service No. 28.

Blaise Computing
2560 Ninth St., Ste. 316
Berkeley, CA 94710
415-540-5441

Programs in Motion offers a shortcut to large-system expert system developers by parlaying its facile, direct handling of decision trees with its new ability to generate production rules in a variety of programming languages. This expert system development software can work as a scratch pad for quick decision-tree prototyping, or even as a working breadboard. Once a decision tree functions as desired, the software

Multi-Edit vs. PIZZA

With EVERYTHING!

- Is your editor OUT TO LUNCH?
- Does it handle ALL OF YOUR NEEDS?
- Is it flexible, programmable and reconfigurable?
- MOST IMPORTANTLY, is it EASY TO USE?

OR WOULD YOU RATHER BE EATING PIZZA?

MULTI-EDIT $99 COMPLETE

VERSION 2

	Multi-Edit	BRIEF 2.0	Norton Editor	Vedit Plus	PIZZA WITH EVERYTHING
Edit 20+ Files larger than memory	Yes	Yes	No	Yes	12 slices
Powerful high level macro language	Yes	Yes	No	Yes	Italian
Full UNDO	Yes	Yes	No	No	No
Visual marking of blocks	Yes	Yes	Yes	No	Looks Good
Line, stream and column blocks	Yes	Yes	No	No	Use Knife
Automatic file save	Yes	Yes	No	No	No
Online help	Extensive	Limited	Limited	Limited	Extensive
Choice of keystroke commands or menu system	Yes	No	No	Yes	Menu Available
Function Key assignments labeled on screen (may be disabled)	Yes	No	No	No	No
Word processing functions	Extensive	Limited	Limited	Extra Cost	Difficult
Complete DOS shell	Yes	No	No	No	Deep Dish
Pop-up Programmer's Calculator and ASCII Table	Yes	No	No	No ASCII	No
Unlimited 'Off the Cuff' keystroke macros	Yes	No	No	Yes	Sauce on Cuff often
Allocates all available memory to compiler when run from within editor	Yes	No	No	No	Lots of bytes
Intelligent indenting, template editing and brace/parenthesis/block matching and checking for C, PASCAL, BASIC and MODULA-2	Yes	C Only	No	Limited	Limited Intelligence
Flexible condensed mode display	Yes	No	Yes	No	Definitely
PRICE	$99	$195	$50	$185	About $12

Get Our FULLY FUNCTIONAL DEMO Copy for only $10!

To Order, Call 24 hours a day:
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In Arizona: 1-602-968-1945
Credit Card and COD orders accepted.

American Cybernetics
1228 N. Stadem Dr.
Tempe, AZ 85281

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Fully automatic Windowing and Virtual Memory
- Edit multiple files regardless of physical memory size
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- View different parts of the same file

Powerful, EASY-TO-READ high-level macro language
- Standard language syntax
- Full access to ALL Editor functions

Language-specific macros for C, PASCAL, BASIC and MODULA-2
- Smart Indenting
- Smart brace/parenthesis/block checking
- Template editing
- More languages on the way

Terrific word-processing features for all your documentation needs
- Intelligent word-wrap
- Automatic pagination
- Full print formatting with justification, bold type, underlining and centering
- Flexible line drawing
- Even a table of contents generator

Compile within the editor
- Automatically positions cursor at errors
- Allocates all available memory to compiler

Complete DOS Shell.
- Scrollable directory listing
- Copy, Delete and Load multiple files with one command
- Background file printing

Regular expression search and translate
Condensed Mode display, for easy viewing of your program structure
Pop-up FULL-FUNCTION Programmer's Calculator and ASCII chart

and MOST IMPORTANT, the BEST USER-INTERFACE ON THE MARKET!
- Extensive context-sensitive help
- Choice of full menu system or logical function key layout
- Function keys are always labeled on screen (no guessing required!)
- Keyboard may be easily reconfigured and re-labeled
- Extensive mouse support
- Easy, automatic recording and playback of keystrokes
- Anchovies easily removed

MULTI-EDIT COMBINES POWER WITH EASE OF USE LIKE NO OTHER EDITOR ON THE MARKET TODAY.

(continued from page 138)

can generate corresponding production rules of program code in C or Pascal. In most cases, these modules can transfer into big expert system environments with little or no change. 1st-Class Fusion for IBM PCs, IBM XT, IBM ATs, or compatibles is priced at $1,295. Reader Service No. 29.

Programs in Motion
286 Boston Post Rd.
Wayland, MA 01778
617-358-7722

The GSS Graphics Development Toolkit for OS/2 is available from **Graphic Software Systems**. The GSS Graphics Development Toolkit for OS/2 provides a high-performance graphics development environment for OS/2-based personal computers. Its high-level functions speed development of interactive graphics applications, and a growing set of device drivers removes the burden of writing driver code for input, display, and output devices. The Graphics Development Toolkit supports advanced features of OS/2 and maintains source code compatibility with the Graphic Development Toolkit for DOS.

The GSS Graphics Development Toolkits for DOS and OS/2 are priced at $495 and $695, respectively. Reader Service No. 30.

Graphic Software Systems
9590 SW Gemini Dr.
P.O. Box 4900
Beaverton, OR 97005
503-641-2200

Tools and Utilities

Flambeaux Software has announced TECH Help! Version 3.3A. TECH Help! is an on-screen reference for system-level programmers. It includes coverage of the DOS and ROM-BIOS services, system variables, I/O ports, installable device drivers, and the layouts and structures of dozens of data tables, bit flags, and switch settings. It covers some topics which are not documented in the official reference manuals. The new version covers DOS 3.3 and the latest versions of the ROM-BIOS.

The display driver has been upgraded to include user-configurable color selection, a simplified way to access multiple Help! manuals, and increased display speed for EGA and VGA monitors.

TECH Help! runs on computers that are compatible with the IBM PC, IBM XT, IBM AT, and IBM PS/2 computers. The program is priced at $89.95. Reader Service No. 31.

Flambeaux Software
1147 E. Broadway, Ste. 56
Glendale, CA 91205
818-500-0044

California 10 PAK, by **California Software Products**, has been upgraded to be used with OS/2 on the IBM PS/2 and compatible machines. California 10 PAK contains 16 programs for browsing, comparing, and sorting the contents of files and memory. System configuration and a map of all installed memory may be displayed. A disassembler produces ready-to-edit-and-assemble source files from .COM files, .EXE files, or any area of main memory. An operating system shell allows users to define the operation of function keys and to create color menus and help screens. California 10 PAK runs under any version of DOS and under OS/2 in protected or unprotected modes. The price for the product is $79. Reader Service No. 32.

California Software Products
525 N. Cabrillo Park Dr.
Santa Ana, CA 92701-5017
714-973-0440

DDJ

golden bow products

Vcache	60	**55**
Vfeature *Hard Disk Utility*	80	**74**
Vfeature Deluxe	120	**111**
Vopt *Hard Disk Optimization Utility*	60	**55**

greenleaf products

Greenleaf C Sampler *specify QuickC or Turbo C*	95	**69**
Greenleaf Comm Library	185	**125**
Greenleaf Data Windows *Includes Source Code*	295	**189**
for OS/2 ... *New*	395	**249**
Greenleaf Functions	185	**125**

komputerwerk products

Finally *BASIC Routines*	99	**85**
Finally Modules	99	**85**
Finally XGraf	99	**85**

lattice products

Lattice C Compiler *from Lattice* ... *New Version*	450	**239**
with Library Source Code	900	**495**
C Cross Reference Generator	50	**37**
C-Food Smorgasbord *Function Library*	150	**95**
with Source Code	300	**179**
C-Sprite *Source Level Debugger*	175	**119**
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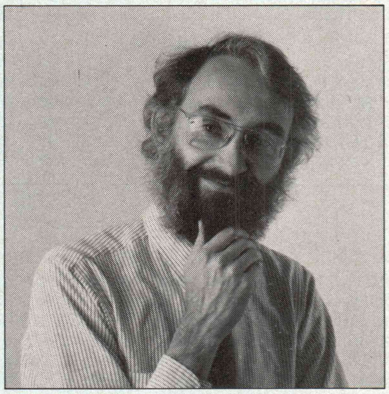

Everything is deeply intertwingled.
—Ted Nelson

I keep reading things that remind me of Ted Nelson's *ComputerLib/ Dream Machines* (either the original landmark manifesto à la collage of 1974 or the radically revised and recently rereleased Microsoft Press edition). There are several possible explanations.

First, Ted talks about a lot of things in *CL/DM*; his is an eclectic light.

Second, he mostly writes about things I mostly read about anyway: the potential of computers, the art of writing, the liberation of the mind.

Third, we remember unfinished business better than finished, and *CL/DM* is a business of unfinishedness; of loose ends; boxes that, once opened, can't be closed again; conceptual gambits; twitching, severed nerves; choose your metaphor. *CL/DM* pitches more itches than it hawks ointments for.

Fourth, everything is deeply intertwingled. That's probably it.

One thing that I've been reading that implicitly invokes *CL/DM* is *The Society of Mind* by Marvin Minsky. *The Society of Mind* presents a model of the mind as a society of communicating processes. The structure of the book reflects Minsky's model and reminds me of *CL/DM*. If you haven't read it, I recommend it.

I've also been reading about highly functionally distributed systems (HFDS): shades of Ted Nelson's *System Xanadu*. An HFDS is a heterogeneous loosely coupled worldwide network of computers and other "intelligent" objects, providing more sophisticated services than any of its components can, says University of Tokyo professor Ken Sakamura, who named HFDS. The multinational, multicompany project Sakamura spawned to implement it has a better name: TRON.

The TRON project envisions a global network and several types of networked devices, including intelligent objects and communication machines. The TRON team is designing a system for the day when a typical room contains a hundred computers, a building thousands, a city millions. The problems that would arise include questions like just how much should my neighbor's air conditioner know about my new lamp?

In an HFDS, neither centralized control nor anarchy would work. The cooperation of groups of components in an HFDS Nakamura intertwingledly calls the "society of computers."

The elements of the TRON project include ITRON, a spec for a real-time operating system for the control of intelligent objects; BTRON, an operating system spec for the human interface components of an HFDS; CTRON, a portable operating system spec for servers that will link BTRON and ITRON elements with gateways and large databases; and MTRON, which somehow ties it all together. The idea is that ITRON talks to machines, BTRON talks to people, CTRON talks to ITRON and BTRON machines, MTRON talks to Matsushita, and Matsushita talks only to God. I think.

Last November, TRON developers from more than 100 firms, including Matsushita, Fujitsu, AT&T, and IBM, met to report progress. Intended to go on-line in the 1990s, TRON is ahead of schedule.

I've been reading a lot about Apple's HyperCard lately, too, since I'm writing a book on it. The "hyper" is homage to Ted's hypertext, although he has some reservations re HyperCard as an implementation of same.

Others have also raised doubts about the market for HyperCard stackware. A panel at January's MacWorld show, discussing stackware prospects, was not encouraging. "Not until there are 100,000 CD-ROM units installed will there be a decent stackware market," one panelist concluded. Stewart Alsop thinks that unless developers, distributors, and Apple all treat stackware like full-fledged serious software, "The stackware business will disappoint just as many people as the 1-2-3 and dBASE templates business did." And Dvorak declares, "I wish those budding stackware developers a ton of luck. They'll need it."

I suspect that the world will little note nor long remember such sage skepticism, even if it turns out to be true. Since Apple brought forth on this continent the computer for the rest of us, Macintosh software development has been beyond the poor powers of unprofessional performers, but now any Sunday afternoon matinee walk-on bit player can prototype a product in a day or two, down to doing a cover letter in card form and printing the disk label.

Heaps of hyperstuff will be hacked together. Publishers will be pummeled in submissions if not into submission, and rejection will be no deterrent to the hyped-up hordes of hyperdom.

Reminds me of what Ted Nelson said about all that white-out on the screen. . . .

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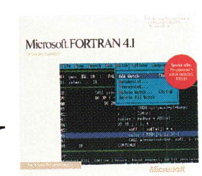

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